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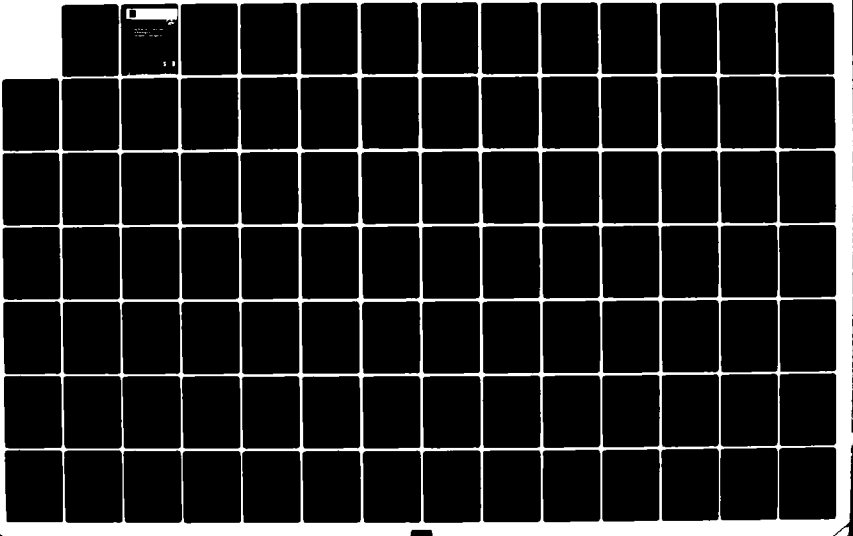

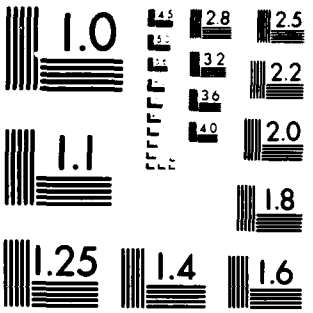

The Role of Science and Technology in Emergency Management

Committee on Emergency Management
Commission on Sociotechnical Systems
National Research Council

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The report identifies appropriate FEMA activities in science and technology. These include: research and development to support FEMA's missions, taking a leadership role in setting research objectives in emergency management within the federal government, establishment of a contingency fund to support interdisciplinary field research of actual disasters, development and maintenance of a system for expressing the needs of users in the planning of emergency management research, interpretation and dissemination of important research results to user.

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The Role of Science and Technology in Emergency Management

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Commission on Sociotechnical Systems
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NOTICE: The project that is the subject of this report was approved by the Governing Board of the National Research Council, whose members are drawn from the councils of the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine. The members of the Committee responsible for the report were chosen for their special competences and with regard to appropriate balance.

The report has been reviewed by a group other than the authors according to procedures approved by a Report Review Committee consisting of members of the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine.

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PREFACE

The Committee on Emergency Management of the Commission on Sociotechnical Systems was organized in February 1981, under the sponsorship and with financial support of the Federal Emergency Management Agency (FEMA), to conduct a study of the role of science and technology in emergency management.

At the time of its establishment, in 1979, FEMA was assigned responsibility for an "all hazards" approach to disaster mitigation, preparedness, response, and recovery in the United States. A part of its general mission calls for the practical application of research and technology to mitigate the damaging effects of emergencies and disasters. This involves two central, interrelated responsibilities: (1) the active conduct of a research program of its own; and (2) the more effective use and application of scientific and technical knowledge from all sources to the problems of emergency management at national, state, and local levels. The first of these responsibilities requires a definition of the role and approach of the FEMA research program, including the policies, strategies, options and priorities to be followed, and interrelationships with other agencies and organizations conducting emergency-related research. The second responsibility assumes

a capability to collate, synthesize, translate, and communicate a vast and diverse body of scientific and technical knowledge in ways that make this knowledge meaningful and useful in practical application.

FEMA recognized that these two responsibilities pose difficult and complex problems for several reasons: the diversity of sponsors, producers, and consumers of emergency research findings; the fragmentation of scientific and technical research endeavors; inadequacies and failures in interdisciplinary communication; and the current lack of adequate mechanisms for assessing the needs of users and for translating and communicating existing knowledge in a form that various users can understand and apply.

Recognizing these and related problems, FEMA requested the assistance of the National Academy of Sciences-National Research Council (NAS-NRC) in fulfilling its responsibilities in this area. Negotiations between the two agencies resulted in a decision to conduct a study of the role of science and technology in emergency management, with a focus on four key questions:

1. What are the potentials for improving the contributions of science and technology to emergency management planning, hazard mitigation, and operations?

2. What related scientific and technical research efforts and bodies of knowledge could make a significant contribution to emergency management policy and practice?

3. What are the candidate roles that the Federal Emergency Management Agency can consider adopting to ensure that there is a maximum

contribution by the scientific and technological community in meeting national emergency management needs?

4. What are the possible approaches that FEMA could use to provide needed scientific and technical assistance to a broad range of public and private institutions, and what are the advantages and disadvantages inherent in each of these approaches?

In forming a committee to address these questions, it was apparent that the membership should consist of a balanced mixture of (1) professionals who had a knowledge of the scientific and technical aspects of emergencies and disasters; (2) emergency managers at local, state, and national levels who have operational responsibilities; and (3) information or education specialists who are knowledgeable about the various sources of disaster-relevant information. The nine members of the Committee on Emergency Management, a special consultant, and the Committee's Executive Secretary reflect these selection criteria. Brief biographical sketches of each of these committee participants are given in Appendix A.

The original plan for this study called for completion of the work in two phases covering a 14-month period. Phase 1 was to include a report on only the first three key questions. Phase 2 was to include the fourth key question plus a preliminary analysis of three specific subsidiary questions. The sponsor's budgetary constraints caused the cancellation of Phase 2 and the compression of the time to complete the study to approximately nine months. Thus this report covers the first three key questions less thoroughly than was originally anticipated.

The Committee's conclusions and recommendations have been placed first in the report for emphasis. Chapter 2 begins our analysis with an examination of the structure and functioning of the U.S. emergency management system. Chapter 3 identifies the needs of the U.S. emergency management system that most directly require the applications of science and technology. Chapter 4 reviews the previous studies on science and technology related to emergency management. Appendix A provides biographical sketches of the participants in the Committee's work. Appendix B lists and describes a number of centralized sources of scientific and technological information relating to emergency management.

Near the end of the contract period, FEMA requested that the fourth key question be addressed in the first phase of the study. This was done by commissioning Claire B. Rubin, Senior Fellow in Public Management at the Academy for Contemporary Problems, to prepare a paper on this subject. Her paper, entitled "Possible Approaches for the Federal Emergency Management Agency to Disseminate Scientific and Technical Disaster-Related Information to Public and Private Users," should be viewed as a very useful supplement to this report.

As Chairman, I thank the Committee members, individually and collectively, for the hard work and creative energies that made this study possible. On behalf of the Committee, I also wish to thank Robert C. Crawford, Assistant Associate Director, Office of Civil Preparedness, National Preparedness Program, FEMA, who served as Project Officer and provided valuable guidance and support. He was ably assisted by Ralph B. Swisher, Program Manager, Civil Defense Division, Office of Civil

Preparedness. I also wish to acknowledge the assistance rendered by the Committee's staff: Charles E. Fritz, Executive Secretary, was largely responsible for launching the Committee's efforts, and he provided valuable support and guidance throughout the course of the study. Helen D. Johnson, Administrative Secretary, and Benita Anderson, Secretary, handled the many administrative tasks connected with this study with cheerful efficiency.

ROBERT W. MORSE, Chairman
Committee on Emergency Management

CONTENTS

CHAPTER 1

CONCLUSIONS AND RECOMMENDATIONS

BACKGROUND

The objective of the Committee's effort was to examine the role of science and technology in emergency management* and to recommend future kinds of research activities that should be undertaken by the Federal Emergency Management Agency (FEMA).

This first chapter presents the Committee's conclusions and recommendations. Other chapters of this report review three subject areas that influenced the Committee's judgments, namely:

- o The nature and functions of the emergency management system (Chapter 2).

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*The term "emergency management" is used throughout this report in a very broad, comprehensive sense. It refers to the organizational and operational capability to manage all types of emergencies and disasters by coordinating the actions--whether of mitigation, preparedness, response, or recovery--of numerous national, state, and local agencies. Emergencies include such risks as wartime civil emergencies, natural hazards, technological hazards, internal disturbances, and energy and material shortages. This definition is adapted from Comprehensive Emergency Management: A Governor's Guide by the National Governors' Association (Washington, D.C.: NGA Center for Policy Research, May 1979), pp. 11-12.

- o The needs of the emergency management system and the relevance of science and technology to meeting those needs (Chapter 3).
- o A review of past studies of emergency management (Chapter 4).

CHARACTERISTICS OF SCIENCE AND TECHNOLOGY IN EMERGENCY MANAGEMENT

Before addressing specific issues about FEMA's possible research activities, we state below some basic assumptions that guided the Committee's considerations:

- o In some degree, almost all science and technology can be applied to emergency management.
- o Most science and technology applicable to emergency management will not be sponsored or conducted by FEMA but by the private sector or by federal agencies such as the National Science Foundation, the National Oceanic and Atmospheric Administration, the Department of Energy, or the Department of Defense.
- o Most problems in emergency management require the application of fairly straightforward science or technology and of basic management principles and tools. Such application is especially needed at the grass-roots level (such as in the development of building codes or operating procedures).

- o There are a few critical areas where sophisticated science and technology is necessary (sometimes on short notice). For example:
  - --environmental predictions.
  - --nuclear effects.
  - --toxic chemicals.
  - --medicine and public health.
- o Key issues in both the "straightforward" and the "sophisticated" areas are the use and transfer of information. Special concern must be given to the use of sophisticated knowledge in emergency operations where there may be little time to make decisions.
- o FEMA is the only governmental agency with all-hazards responsibilities and with a system of linkages to the local level. FEMA thus is in the best position of all agencies to be aware of the needs of users in the emergency management system.

The remainder of this chapter is divided into three parts. First, the Committee states its central conclusions; second, we outline a set of recommended research roles for FEMA; and third, we outline a series of action options for FEMA's consideration.

CENTRAL CONCLUSIONS

The Committee's central conclusions can be stated briefly as follows:

- Better use of science and technology by the emergency management system requires improvements in the transfer and use of existing technical knowledge--i.e., it requires better management of technical information.
- There is a need to improve coordination among federal agencies dealing with emergency-related science and technology.
- There is a need for better inputs from user groups to research programs in emergency management.

RECOMMENDED RESEARCH ROLES FOR FEMA

The Committee believes that the following points describe an appropriate range of activities for FEMA in science and technology:

- Conduct research and development activities in direct support of FEMA's missions. These kinds of programs (similar to those FEMA now supports) should address such issues as the entire range of civil defense problems, mitigation strategies and practices, and problems that bear on the effectiveness of the emergency management system. Development of equipment should be limited to unique

items (such as fire equipment or nuclear radiation detectors) where there are no other sponsors.

- o Take a leadership role in setting research objectives in emergency management within the federal government. This recommendation recognizes FEMA's unique responsibility in the federal structure as well as the fact that most research will be sponsored by other agencies. This recommendation, however, does not imply that FEMA should manage or otherwise control the programs of other agencies.
- o Establish a contingency fund to support interdisciplinary field research of actual disasters. Research programs in emergency management would be strengthened if there were contingency funds that would enable qualified research groups to take advantage of the circumstances offered by a wide variety of emergencies and disasters whose time and place of occurrence cannot be accurately forecast.*

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*The Natural Hazards Research and Applications Information Center at the University of Colorado currently has a small amount of money to support exploratory field research, but the amounts available to fund any given project are insufficient to support the needed large-scale, systematic field studies. The Committee on Natural Disasters of the National Academy of Sciences-National Research Council also has funds for field research, but these are limited to engineering-type studies of natural disasters.

- o Develop and maintain a system for expressing the needs of users in the planning of research in emergency management. The Committee believes that there is a wide gap between the research community in emergency management and the user community (legislators, planners, local emergency managers, etc.). FEMA is in a unique position to close that gap.
- o Interpret and disseminate important research results to user groups. This recommendation, in a sense, is the inverse of the previous one. It recognizes that research results have little practical impact (except on other researchers) unless special efforts are made. There are no "natural" channels by which research results influence the broad community involved in emergency management.
- o Develop and maintain a system whereby emergency managers at all levels can have direct and quick access to technical knowledge in a wide range of fields. The fulfillment of this recommendation clearly must be met in stages, but the Committee feels that it is an extremely important long-range objective.

ACTION OPTIONS FOR FEMA

The Committee recognizes that the recommendations made above are not easily accomplished. Clearly, it is easier to point to deficiencies in the transfer of information than it is to construct effective remedies. We recognize, too, that there is no unique approach to some of these objectives, so a variety of options are suggested:

- o FEMA should consider convening periodic interagency meetings, or jointly sponsoring symposia or workshops, that would help establish research objectives in emergency management within the federal government.
- o FEMA should consider organizing periodic conferences of user groups, perhaps convened through regional offices, to provide inputs to research directions.
- o FEMA should consider making occasional major review efforts (perhaps one each year) that would address the potential applicability of new technologies in emergency management. These should involve governmental, industrial, and academic participants. Two suggested areas for consideration are applications of new technologies to manage information, and applications of remote sensing.

- o FEMA should consider developing an emergency management information center that could provide access to emergency management data via computers and to other relevant data systems.* Initially this should be intended to meet only the needs of FEMA headquarters and the regional centers. The system should be designed for later expansion to serve a wider community.
- o FEMA should consider developing and maintaining a system whereby the headquarters and regional offices could have direct and quick access to scientific and technical experts in a variety of fields. This recommendation recognizes that no computer-based information system can provide expert, interpreted advice. There are many situations when decisions in an operational situation require the firsthand advice of the most knowledgeable people.
- o FEMA should consider establishing a research user advisory group, composed of emergency managers from local, state, and regional levels. This group would suggest needed research, review FEMA's proposed research plans, and advise FEMA on methods for implementing research findings.

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*See Appendix B for a listing and description of relevant data bases that can be accessed via computers. This appendix also lists other centralized sources of scientific and technological information relating to emergency management.

- FEMA should consider establishing a national scientific advisory group to assist FEMA directly in its emergency problems and to advise FEMA in developing a network of scientific emergency advisors.

CHAPTER 2

THE U.S. EMERGENCY MANAGEMENT SYSTEM

INTRODUCTION

In recent years there has been an increasing concern, both on the part of the public and governmental officials, with the consequences of natural and man-made disasters. The accident at the Three Mile Island nuclear power plant and the eruption of Mount St. Helens emphasize the potential vulnerability of large segments of the population and the need for prompt and coordinated responses to ensure public safety. At the same time, these events underscore the need to devise and adopt appropriate preventive measures to reduce the probability of man-made disasters and the negative consequences of natural disasters. Furthermore, it is becoming apparent that potential risks from man-made or technological sources are increasing as existing technologies grow and change and new technologies develop. The public, as well as government at all levels, is sensitive to the facts that the number and varieties of hazardous materials shipped by land, sea, and air are increasing, that the number of nuclear power plants is increasing, and that new energy technologies bring with them new and different risks to public health and safety. Also, these developments are taking place against a backdrop of continuing risks associated with nuclear attack, civil disorder, and natural hazards, the

potential consequences of which are being exacerbated by increases in population size and density, by changes in the age structure (increases in average age), and by economic uncertainty.

The Federal Emergency Management Agency (FEMA) was organized to be the single point of contact at the federal level to deal with all emergencies. It has the responsibility to implement federal programs involved with preparedness, mitigation, response, and recovery for emergencies ranging from natural and man-made disasters to nuclear attack. Specifically, the director of FEMA has been delegated the authority to administer the Disaster Relief Act of 1974, PL 93-288. Section 201 of that act states in part:

> Sec. 201(a) - The President is authorized to establish a program of disaster preparedness that utilizes services of all appropriate agencies (including the Defense Civil Preparedness Agency) and includes
>
> (1) preparation of disaster preparedness plans for mitigation, warning, emergency operations, rehabilitation, and recovery;
> (2) training and exercises;
> (3) post-disaster critiques and evaluations;
> (4) annual review of programs;
> (5) coordination of Federal, State, and local preparedness programs;
> (6) application of science and technology;
> (7) research

Items 6 and 7 clearly give FEMA the authority to incorporate science, technology, and research into an overall emergency management program.

This chapter briefly describes the system through which comprehensive emergency management is put into practice in the United States. The discussion of the U.S. emergency management system is divided into two parts: first, the tasks to be accomplished by the U.S. emergency management system are defined, and, second, the components of the system are described and their interrelationships are explored.

THE EMERGENCY MANAGEMENT SYSTEM

Some would say that it is presumptuous to speak of an emergency management system in the United States. The term "system" suggests an integrated collection of components, with defined and agreed-upon obligations and responsibilities, that interact in concert to achieve a given goal. Emergency management in the United States is still fragmented and incomplete, but there appear to be both a desire and a plan, particularly on the part of the federal government and the states, to move toward establishing an emergency management system. Thus emergency management has been changing and evolving, particularly since the late 1970s.

The sections that follow describe both what is and what may be. Links not now present are described as such, and problems are appropriately identified. Since emergency management comprises a complex and extensive set of agencies, programs, and interrelationships, the present discussion is necessarily both compressed and simplified. It should be noted that the charge to the Committee did not include an evaluation of the effectiveness of the U.S. emergency management system. Rather, in the ensuing discussion we have tried to construct a model of how the system should function when fully developed.

Emergency Management Tasks

Comprehensive emergency management directs attention to the full range of options for coping with emergencies. Emergency-related activities may be grouped in various ways that reflect differing levels

of specificity and take into account differing conceptions of the time phases in emergency management. One such schema groups emergency-related activities into four discrete but interconnected categories distinguished by the time phases of a disaster's impact: mitigation, preparedness, response, and recovery (National Governors' Association, 1978).

Mitigation activities are directed, where possible, toward eliminating the causes of disasters or significantly reducing the chances that a disaster will occur. The focus here is on prevention--i.e., stopping disasters before they happen. In this sense, mitigation activities have been most effectively employed for technological hazards in which, once a hazard or threat is identified, it is sufficiently subject to human control that steps can be taken to minimize the probability of an incident. For example, with respect to the transportation of hazardous materials by highway, the probability of risks to public health and safety can be minimized by establishing rules regarding the strength and construction of containers, by checking the safety of transport vehicles, by routing vehicles through low-density population areas, and by timing shipments to coincide with periods of low activity in urban areas.

Another mitigation strategy, often used with natural hazards or other events over which humans have little control, involves simply acknowledging the existence of the hazard and manipulating human patterns of use in ways that minimize the consequences of impact. Thus management strategies in land use that restrict residential construction in

floodplains are important mitigation measures against riverine floods. Likewise, building codes can be established to enable structures to better withstand hurricane-force winds or earthquake shocks.

All of these mitigation activities are long-range measures; they are taken well in advance, either in response to a specific disaster or after a risk has been identified, and they are aimed at reducing a hazard or, more simply, at minimizing the chance that an incident will become a disaster. It is interesting that, in the history of attempts at emergency management in the United States, the smallest share of resources has traditionally been devoted to mitigation activities.

Intimately related to mitigation measures are disaster preparedness activities. These are activities undertaken to protect human lives and property from threats that cannot be manipulated via mitigation measures or from which only partial protection may be achieved. Preparedness activities may be divided into two general categories: actions providing an alert that an impact is imminent, and actions enhancing the effectiveness of emergency operations. Preparedness measures that provide an alert include the development and improvement of detection and prediction technologies that can alert authorities to the presence of threats. Among such technologies are riverine flood detection systems, radar systems to detect and track severe storms, and equipment designed to detect functional and coolant irregularities in nuclear power plants used to generate electricity. Warning systems that convey information from authorities to the public--regarding, for example, tornadoes, tsunamis, hurricanes, etc.--also fall into this category. Preparedness measures aimed at enhancing emergency operations include a variety of

activities, such as developing routing plans for evacuations, stockpiling material for shelters, assembling lists of resources and their locations, training personnel, and conducting drills or rehearsals of emergency plans.

Therefore, like mitigation measures, preparedness activities are conducted or undertaken in advance of disasters. They represent ways of protecting life and property when disasters strike. However, it has been documented that preparedness activities have historically received relatively few resources compared with response and recovery activities. There is a general cycle in which a great deal of interest in preparedness issues is generated immediately following a major disaster, but as time passes this interest declines significantly. Because translating concern into budget allocations and programs that can feasibly be implemented often requires considerable time, traditional emphasis in this area has been low. In developing the concept of comprehensive emergency management, a concerted effort has been made to establish the importance of both mitigation and preparedness activities.

Emergency response activities are conducted during and immediately after the period of impact and focus on assisting the affected public as well as on minimizing damage from secondary effects or repeated impacts. Some of the more visible response activities include search and rescue, emergency medical care, and shelter for evacuees and other victims. Also, operations may be mounted to counter secondary threats, such as urban fires in earthquakes, contaminated water supplies or other public health threats in hurricanes, contaminated wildlife or fish after a toxic chemical spill, or floods and mudflows from a volcanic eruption.

Recovery activities begin shortly after a disaster's impact and may extend for long periods of time. The objective of recovery measures is to restore both the physical parts of the community and the quality of life to at least the same levels as before the disaster, with, if possible, the introduction of improvements. Traditionally, recovery has been thought of in terms of short-range relief and rehabilitation measures and longer-range reconstruction measures. Relief and rehabilitation activities usually include clearing debris and restoring access to the affected area, getting affected business and industry back into operation, restoring government and community services, and developing a temporary system to care for victims with housing, clothing, and food. Reconstruction activities tend to be dominated by the rebuilding of structures--buildings, roads, bridges, dams, etc.--and by efforts to restore the affected economic system. Some communities, as was demonstated after the Great Alaska Earthquake of 1964, may also treat the reconstruction phase as an opportunity to institute their prior plans for change, or they may introduce mitigation measures into rebuilding to improve upon predisaster conditions (Anderson, 1970).

It should be pointed out that, in most cases, the bulk of the resources used in the recovery phase (particularly reconstruction) come from extracommunity sources. In the United States these sources tend to be primarily federal, with private organizations and state governments having a smaller, though important, role. Also, as Charles Fritz (1971) has indicated, most of the money and resources devoted in the United States and other countries to what we call disaster management has been directed at the recovery phase.

The preceding paragraphs reviewed the desired "outputs" of an emergency management system. That is, a system aimed at the comprehensive management of emergencies should, as part of its operation, promote mitigation measures, preparedness activities, and the capability for response and recovery. Two important points should be reiterated here. First, the activities are somewhat time-phased: mitigation and preparedness measures take place and should be planned for in advance, but can also be performed during recovery. Response and recovery are postimpact activities. Thus practical problems accompany the development of mitigation and preparedness activities because they must usually be done during "normal" times when a threat is not imminent.

Moreover, it may be virtually impossible to obtain funds (especially federal funds) for planning and mitigation efforts before the disaster occurs and before the Presidential declaration of a major disaster. Historically, it has been difficult to mount efforts to engage in these sorts of activity. Response and recovery take place in the context of a disaster's impact--clearly times that are not normal--and benefit from the operation of an emergency social system as well as from the cohesiveness of communities that is usually promoted in the short-range aftermath of a disaster (Fritz, 1961).*

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*This finding, of course, does not negate the need to plan for response and recovery before a disaster's impact.

Perhaps equally important in hampering mitigation and preparedness are the limits imposed by the state of technical knowledge regarding various hazards, particularly when resources are scarce. The state of technology limits the nature and types of mitigation and preparedness activities that can be undertaken. When a potential disaster cannot be detected in advance or when the technology for doing so is crude, as in the case of earthquakes, volcanic eruptions, civil disorders, or terrorist events, mitigation may be simply impossible or at best very complex. Without a technology for advance detection, advance warning is not possible either. Thus, at least historically, it has seemed both expedient and logical in some cases to devote resources largely to response and recovery. The approach in the future, if comprehensive emergency management is to be successfully implemented, should be to acknowledge existing limits, but to develop creative mitigation measures within these limits and aggressively pursue a line of research and development that will improve the state of technology.

Having reviewed the tasks associated with management, we now look at the actors involved in the emergency management system. The following section sketches the structure within which mitigation, preparedness, response, and recovery activities must occur.

Components of the Emergency Management System

One can identify four primary actors in the U.S. emergency management system: local governments, state governments, the federal government, and private organizations. These components are quite diverse. They tend to have different organizational structures, different sizes,

different available skills, different political mandates, and different publics to which they are accountable. They must, however, work together in a complementary fashion to achieve comprehensive emergency management, or, for that matter, to execute effectively any single task among the four activities of comprehensive emergency management. These actors in the system have not always fitted together smoothly. Furthermore, new problems associated with changes in the emergency management philosophy and structure at the federal and state levels have developed.

Some have recently argued that conditions are improving and that the responsiveness of the system will be enhanced further as the philosophy of comprehensive emergency management evolves and becomes more entrenched. The federal consolidation under FEMA gives states and local communities a single contact point for federal coordination. Also, the National Governors' Association has been very active since 1978 in promoting a clearer role for states in emergency management, which helps local officials determine the types of assistance that can and cannot be obtained regionally.

In the following sections we seek to characterize, for each component in the emergency management system, its perspective on emergencies, the kinds of unique resources it brings to emergency management, and the tools (or powers) it has to engage in comprehensive emergency management.

Local governments or localities are the component closest to the problem. Indeed, it has been said that disasters are local events. For successful emergency management, the motivation, and sometimes the initiative, must come from localities. Although it is not always acknowledged by other components, the locality has been and will continue

to be the most important component of the system. Localities are subject directly to the harsh realities of disasters, and no matter what any other components may do it is incumbent upon the locality to take some action. Most of the problems arise when federal, state, and local perceptions of priorities differ.

It is interesting that although the locality is the component closest to the disaster, its resources for coping with disaster are smallest. Local governments have a smaller tax base in general and are faced with a variety of local demands, some obviously more pressing than hazard management. In such an operating environment, a locality is often forced to allocate resources to problems that have a higher priority than hazard management.

The availability of resources shapes the kinds of actions that a locality can take with regard to emergency management. It can pass ordinances and regulations aimed at mitigation. To some extent, land use patterns can be influenced and building codes can be adopted to protect new structures. Localities can also create and sustain preparedness measures, particularly warning systems and evacuation plans, as well as response measures, such as search and rescue teams and certain kinds of stockpiles. Local police and fire departments can accomplish many such activities. It is more difficult, and often impossible, for a locality to undertake measures that require personnel with special skills or, sometimes, just extra personnel. In some cases the problems of resource shortages can be reduced by groups of localities banding together either in county or regional structures for emergency management. Under these circumstances the county or regional unit becomes the focal unit for the other components of the emergency management system.

In summary, localities have faced the reality of comprehensive emergency management for some time. They have not had the luxury of diversification; a single organization has been forced to deal with all phases of activity in all types of disaster. The available resources have usually been the limiting factors in determining which types of disaster and which phases of activity get the most attention.

State governments have legislative mandates to engage in emergency management activities. There are two important aspects of a state government's role in emergency management. First, states must engage directly in emergency management activities, particularly for hazards that have a broad scope of impact. Threats associated with nuclear power plants, transportation of hazardous materials, hurricanes, and some volcanic eruptions, for example, tend to affect many political jurisdictions, and states and localities must both undertake emergency management activities. The tools available to states for emergency management are largely laws and regulations. Governors can also intervene directly by using special emergency powers, which usually apply during response and recovery phases. Also, by virtue of their greater resource bases, state governments are better able to maintain personnel and programs related to mitigation and preparedness. While such programs directly apply to issues of emergency management at the state level, relevant plans and operational concepts may also be conveyed to localities.

Coordination is the second aspect of a state government's role in emergency management, particularly during the response phase. Both FEMA and the National Governors' Association have recently emphasized the role

of the state in coordinating interactions between the federal government and localities. In all phases of emergency management, the state can help to link localities with appropriate federal resources. It can also coordinate within the state, expediting both linkages among localities for mutual support and linkages between localities and the private sector.

Much of the role of state governments within the emergency management system lies in promoting effective mobilization of resources. Within a state, the state government can encourage emergency management activities by localities, build links among localities and between localities and emergency-related private organizations, and provide assistance to localities when disaster-induced needs exceed their resources. Outside a state, it can help to connect localities with appropriate sources of federal aid, as well as with national private organizations.

The extent to which different states are currently performing this role is highly variable. While many states are moving in this direction, and the National Governors' Association is widely disseminating information on how states can engage in comprehensive emergency management, much remains to be done before most states can effectively fulfill the role described above.

The third component of the U.S. emergency management system is the federal government. Federal resources for emergency management are extensive and diverse in that they apply to all phases of activity and encompass many different types of potential disasters. Some of these resources represent considerable technological sophistication, such as the National Weather Service's system for predicting, detecting, and monitoring hurricanes and the Nuclear Emergency Search Team (NEST), which

maintains skilled personnel and exotic equipment used for, among other things, assessing the validity of nuclear blackmail threats. Also, federal resources tend to be located in various departments and agencies, at least to some extent, because of their very specialized nature.

The Federal Emergency Management Agency was established in 1979 to serve as a focal point for federal efforts in emergency management. FEMA serves as the coordinator of all federal efforts related to emergency management--mitigation, preparedness, response, and recovery--for all types of emergencies: natural disasters, nuclear attack, civil disorder, and technological disasters. FEMA is involved in some emergency management activities directly; for example, for nuclear attack preparedness it issues planning guidance, develops model plans, and provides technical information on characteristics of the threat. FEMA also promotes emergency management activities by the other components of the system through information programs, planning grants, and the sharing of both personnel and the costs of personnel. Finally, a large part of FEMA's role is devoted to overseeing the federal emergency management system and coordinating the federal effort with states and localities. FEMA's matching of state and local needs with appropriate federal resources is one of the most publicized of the organization's goals.

The federal government, through FEMA and many other emergency-related agencies, extensively influences the behavior of the other components of the emergency management system. FEMA's authority is based on legislation, executive orders, and regulations. It can influence other components in the system by establishing rules or by using its influence to get executive orders issued or legislation passed. In

addition, the federal government is influential because it is the most important source of financial aid for other components of the emergency management system. Grants for preparedness planning and funds for personnel and administrative support come from the federal government, as do special services, research, and technical information on emergency management. In general, the federal government is an important potential source of long-range resources for recovering from all types of disasters. The federal government also provides most resources for all phases of activities relating to nuclear attack and civil disorder (e.g., terrorism and riots). Finally, the federal government sponsors most research to develop mitigation measures and provides much information, research, and development in preparedness, particularly with respect to technology for predicting or detecting threats. Therefore, the federal component is engaged in three very broad activities: it promotes emergency management among other components, coordinates among all the components, and provides resources for emergency management.

Private organizations or the private sector form the fourth and probably the most diverse component of the emergency management system in the United States. One may think of this component as consisting of two general types of organizations. First are organizations that exist primarily to fulfill roles in some (or all) phases of emergency management. The American National Red Cross, the Salvation Army Disaster Relief Program, the Mennonite Disaster Service, or local search and rescue teams represent this type of organization. The second type consists of those organizations that routinely pursue some private line of business unrelated to emergency management but that have some

equipment or expertise potentially useful in emergency management. For example, during the response phase of riverine flood disasters, emergency operations personnel may need heavy construction equipment--bulldozers, earthmovers, etc.--and attempt to obtain it from a local construction company. We should emphasize that what we here describe as the private sector includes organizations that are national in scope, as well as those with regional or local foci, organizations ranging in size from a handful of people to hundreds of employees.

Historically, the role of the private sector in the emergency management system has focused on the response and recovery phases and has involved the provision of special materials or skills. Specialized material tends to come from organizations not exclusively oriented to emergency management, ranging from the above-mentioned construction equipment used in floods to radiological detection or decontamination equipment for nuclear disasters. Special skills usually come from organizations that include disaster management among their goals, ranging from skills provided by the American National Red Cross for sheltering and feeding evacuated populations to the identification and description provided by CHEMTREK* of appropriate safety measures to be used with hazardous chemicals. Both types of organizations, as well as the general public, contribute volunteer manpower to emergency management operations.

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*The Chemical Transportation Emergency Center (CHEMTREK), established and funded by the Chemists' Manufacturing Association, is located at 2501 M Street, N.W., Washington, D.C. 20037. It is operated 24 hours per day by a nine-person staff and can be reached by a toll-free call from anywhere in the United States (800-424-9300). The center presently has information on over 3,600 chemicals and 45,000 trade names.

In recent years private organizations have been more active in the mitigation and preparedness phases of emergency management. The American National Red Cross continues to be active in preparedness for nuclear attack, and community action and public interest groups have become involved in preparedness for nuclear power plant accidents, earthquakes, and hurricanes. Much of this involvement is both hazard- and location-specific, but it nonetheless represents both an increase in the level of involvement by the private sector and a departure from the tradition of involvement in postimpact activities.

With respect to the U.S. emergency management system, the private-sector component appears to perform three functions: (1) it identifies and publicizes the concerns of citizens pertaining to emergency management issues, (2) it supplies volunteer manpower in all phases of emergency management, and (3) it contributes special material and skills to emergency management problems. It appears to be inappropriate to characterize the private sector as fulfilling the largely perfunctory role of supporting other components of the system. While it is true that the role of the private sector centers on support activities, it must also be acknowledged that private organizations can assume active leadership. For example, private organizations--such as citizens groups with the Love Canal contamination--can identify a need for emergency management and then prod other components of the system to take action. Thus the private sector may influence other components of the emergency management system by lobbying, by taking the initiative unilaterally, and by providing in volunteer work for other components directed toward specific aspects of emergency management.

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CHAPTER 3

NEEDS OF THE EMERGENCY MANAGEMENT SYSTEM

This chapter's purpose is to identify those types of needs in the emergency management community that most directly require the applications of science and technology.* At the outset, however, it must be recognized that most problems in emergency management do not have purely technical solutions. The characterization of the nation's emergency management system given in the previous chapter makes it clear that the system has certain inherent shortcomings that the application of science and technology cannot relieve. Among these are:

- Mitigation and preparedness activities involve trade-offs between short-term and long-term interests. Expenditures and preparations for unlikely future events are usually short-changed in competition with normal demands.
- Emergency management involves the cooperation and coordination of many governmental groups and sectors

*The "needs" described in this chapter were assembled by the Committee from a variety of sources: the experiences of its members, the presentations of participants at its meetings, and a review of published reports.

of society whose "normal" business may not require such interaction. Jurisdictional and management problems, therefore, are inevitable and complicate the application of technology to emergency management.

- o Response to disaster can only be made with existing and available assets. Since there is always some scale of emergency above which the quality of response may decrease, response is limted by assets. There is no technical "fix" to this problem.
- o The ability to forecast the time, place, and outcome of unusual events is inherently limited, so our ability to prepare for their consequences is also limited. This is especially true for the potentially most destructive events, such as a major urban earthquake or nuclear war.

The above points are made to emphasize that the application of science and technology within the emergency management system must be conditioned by the nature of the system itself as well as by the character of emergencies.

GENERAL AREAS OF NEED

A number of general areas of need center on the structure and functioning of the U.S. emergency management system. These include the following:

- Operational Integration of the Emergency Management System. Perhaps the most general need is for the so-called system to begin functioning in reality as an effective system. In particular, the partnership of local, state, and federal authorities must become an operating reality on a day-to-day basis. At a minimum, this requires (1) that states and localities follow through with the creation and staffing of emergency agencies and (2) that FEMA stabilize both its administrative structure and personnel. Above this minimum, FEMA must arrive at a clear definition of its role as coordinator and establish active working links with other federal agencies and the states.
- Development of an Emergency Management Profession. The role of an emergency manager needs to be professionalized and more clearly defined. The training and expertise of emergency managers in the United States is highly variable, with only a few having specific training in the nature of various hazards and their management. Furthermore, as technological emergencies increase in number and intensity, the need for managers to use technical information in developing a response also increases. It is not possible to train a manager to deal with all aspects of all

emergencies. Instead, managers must understand basic principles of emergency management and be able to interpret information from a variety of specialized advisory sources.

- o Interagency Coordination. Traditionally, when considering the nature of responses to disaster, researchers and emergency managers have focused on the response of the public to different measures. Equally important, however, is the response of official organizations to the threat. Viewed from the latter perspective, it is apparent that there is a need to enhance the effectiveness of the coordination between different agencies responding to the same disaster. To promote an effective response in such situations, all responding agencies must be clear about their individual responsibilities and understand how their activities combine with those of other agencies in a comprehensive response effort.
- o Public Involvement in the Planning Process. There is a need for all levels--local, state, and federal--engaged in emergency planning to develop more effective strategies for disseminating information about emergency plans to the public. Particularly in the area of civil defense, too much time has been spent communicating

plan-relevant information among different planners, and not enough effort has been devoted to telling the public what will be expected of them in the event of an emergency. Experience with natural hazards confirms that even the most carefully developed plan can fail if the public is not involved at some point in the planning process.

- o Technical Information Management. This phrase encompasses a wide range of needs involving the improved use and transfer of specialized knowledge within the emergency management system. The following are specific examples of need:
  --the translation of technical information into forms that make it "usable" at the appropriate level of the emergency management system.
  --the provision of technical information quickly in emergency response.
  --the interpretation and dissemination of research results and new technical information to potential users.

Discussion

The first four of the needs identified above are largely managerial or organizational in nature; science and technology do not play a central role in meeting them.

The problems associated with the management of technical information, however, are intimately linked to science and technology. Not only does the specialized nature of the information create problems in the first place, but the application of technology is basic in effectively managing the information.

The Committee believes that the most important need that it has identified is for improved use of technical information within the emergency management system.

One important initiative that would improve the situation would be to start the development of a national emergency management information system. This could be developed in stages, with the system initially directed at serving FEMA headquarters and the regional directors. Such an effort would require creating a series of files that would contain those essential elements of information that can facilitate planning for, or response to, a range of emergencies. The computerization of such data, to be retrieved subsequently in narrative, statistical, or graphic form, requires a thoughtful system design as well as comprehension by management of the interactions between the human and technological components of such systems. Illustrative of such data bases would be those:

- containing descriptive information on selected past disasters and the resources employed in ameliorating them.
- featuring profiles of individuals and organizations possessing particular skills and other special qualities that could be marshalled before or during emergencies.

- identifying technology-supported resources and services that could be drawn upon to meet certain needs in emergencies, e.g., communication networks.

A centralized emergency management information system is just one step that could be taken to improve the use of technical information.

A very active current technological development that could have important impacts on the handling of technical information at the local level is the "home" or "personal" computer. Such systems can allow local emergency managers to have quick access to preplanned emergency-related information of special interest to that area. In addition, such systems can give access to relevant national data systems.

In concluding this discussion of general areas of need, the Committee strongly recommends that FEMA place more stress on the need for local, state, and regional input to research and development plans and programs and to information management systems. For example, the information and communication network needed to handle emergencies effectively should permit local and state emergency managers, through regional and national centers, to contact other managers who have faced similar problems in previous emergencies. Much vital information remains in the heads of professional emergency managers, and an adequate information and communication system should permit these experienced persons to be identified and to transmit their knowledge and advice to other managers facing immediate emergency decisions and operational problems.

SPECIFIC AREAS OF NEED

The Committee has identified the following areas of need as ones that especially require the application of science and technology:

- o Forecasting and Warning. There is a continuing need to improve both the quality (i.e., the timeliness and specificity) of warnings concerning floods and severe storms and the ways in which such warnings are used in emergency management. Even though the scientific capability to make predictions always falls short of the full desires of emergency managers, improvements in this area have large potential payoffs. While there is now little scientific basis for predicting earthquakes, there is a clear need for prediction methods. There is also a continuing need for forecasting the location, likelihood, and scale of future potentially disastrous events. Such forecasting (e.g., with respect to climate or earthquakes) is needed to aid long-range mitigation strategies.
- o Nuclear Events. There will continue to be a wide range of needs in the area of civil defense and in anticipation of possible accidents or sabotage that might release large amounts of radioactivity. Examples of specific issues are:
  - -- food distribution and strategies for relocation during crises.

-- understanding the potential range of effects from accidents.

-- postdisaster cleanup technologies.

-- speeding up the recovery of contaminated farmland.

-- prediction of atmospheric transport.

-- better nuclear instrumentation.

-- public health strategies for large-scale events.

o Methods of Risk Analysis. Better quantitative measures and methodologies are required both to assess natural and sociotechnical risks and to guide the optimal use of resources in mitigation and preparedness. Such methodologies are important for policy guidance at the local, state, and national levels as well as for use by private industry, banks, and insurance companies.

o Methods for Defining Hazard Zones. Better techniques are required to define and determine hazard zones for such natural hazards as floods, storm surges, and earthquakes.

o Improved Mitigation Strategies. There is a continuing need to understand the effectiveness and consequences of existing mitigation techniques (insurance, building codes, the delineation of hazard zones, etc.) and to identify new incentives for mitigation. One incentive method that should be examined is the transfer of mitigation strategies

from states and localities that have experienced recent severe disasters to other states and localities that have not had such experiences. Capitalizing on the occurrence of serious disasters in one area to encourage mitigation measures in others needs further effort. Particularly with technological hazards, FEMA needs to take the lead in identifying possible mitigation measures and in communicating this knowledge to emergency managers and policy makers at state and local levels.

- o Improvements to Structures. There is a broad need for design and construction techniques that strengthen structures against wind, flood, and earthquakes. Short-range inexpensive modifications to existing structures or construction techniques are particularly desired because they can have large and immediate payoffs (as is the case with trailer tie-downs). There are also special needs to reduce the vulnerability of structures housing critical emergency assets, such as fire apparatus, communication equipment, and emergency supplies. Continuing studies should be made of the dual use of future structures for protecting the population from radiation and blast in the event of nuclear war.
- o Communication. Disaster response in all emergencies, from a local chemical spill to nuclear

war, requires communication systems. There are special needs in understanding the capabilities, limitations, and vulnerabilities of available systems and in knowing how best to use alternative modes of communication. Preparedness planning must realistically anticipate the effects of damage to normal communication systems. Examples of specific issues are:

--the effects of electromagnetic pulse (EMP) on communication systems.

--the vulnerability of communication systems to sabotage or terrorist attack.

--the uses of alternative modes of communication, such as satellite relays, decentralized systems (e.g., citizens band radio), or mobile command centers.

o Understanding Human Response. Human behavior is perhaps the most important factor in determining the effectiveness of emergency management measures. There are many needs for a better understanding of likely human responses and for ensuring that policies, plans, and procedures incorporate such knowledge. Examples of areas where such needs are important include:

--public response to hazard warnings.

--prevention and control of urban riots.

--relocation and evacuation methods.

--public information and communication policies.

--relief and rehabilitation strategies.

--response to mitigation incentives or regulation.

--role of the family and other social institutions in disaster response and recovery.

o Uninterrupted Power Sources. Because most emergency organizations depend on electrical power sources, and emergency responses are greatly hampered by their disruption, replacement capabilities must be considered. In many instances, such backup resources do not exist or have limited capacity and endurance.

o Hazardous Materials Management. A wide range of ever-changing needs are associated with the storage, handling, and transportation of hazardous materials. Areas of concern are:

--design of containers and vehicles.

--understanding health and environmental effects if accidents occur.

--determining appropriate response strategies if accidents occur.

--developing appropriate standards and policies for transportation.

o Search and Rescue Techniques. There is often a need for finding people who are buried under collapsed

structures or in rubble. Search and rescue techniques depend either on trained dogs or on equipment using infrared or acoustic sensors. There is a need to improve and simplify such techniques.

- o Postdisaster Damage Assessment. Emergency managers need rapid methods to assess damage in order to determine the resources required during the response phase and to begin appropriate relief and rehabilitation measures. There is also a need to systematize the way damage assessment and loss information is communicated to emergency managers at all levels. Techniques for damage assessment must address the social and physical consequences of a disaster's impact and not simply involve an inventory of numerical losses. Furthermore, damage assessment should be treated as a process, to be periodically updated and revised throughout the response and recovery periods.
- o Postdisaster Analysis of the Emergency Management System. There is a need for an objective analysis of the functioning of the emergency management system in a variety of actual disaster situations. Such objective reviews, if done in a systematic manner, could guide policy at all levels of government. It is especially important, for example, for a local emergency management director

to know what situations have come up in similar communities and how they were handled (or mishandled).

- Socioeconomic Aspects of Long-Term Recovery Programs. There is a general need to understand better the socioeconomic aspects of longer-term restoration and recovery programs. Much past emphasis has been given to the restoration of structures after natural disasters, but little attention has been devoted to methods for reestablishing or maintaining social networks in stricken areas. In the event of a significant atmospheric release of radiation from a nuclear power plant or transportation accident, an area may become uninhabitable for very long periods of time. Present recovery strategies are inadequate for such an event.
- Anticipation of New Problems. Potential new emergencies can be created by the various gradual changes taking place in our society, such as population shifts (both in age and geographical distribution), increasing urbanization in arid climates, alterations in patterns of energy consumption, or technological innovations in industry and agriculture. Urban drought and the increasing vulnerability of our society to

large-scale terrorist activities are just two of many possible examples. There is a need to anticipate such problems, to determine their probable character, and to identify mitigating or preventive steps.

Discussion

The problem areas listed above are candidates for future research and development programs. Clearly, however, FEMA cannot address most of them through its own programs; indeed, the responsibility to conduct such programs properly belongs with the agency having the principal competence in the underlying science or technology.

The Committee believes that the conduct of such emergency-related research and development within the federal government could benefit considerably by two initiatives: (1) more active efforts at interagency coordination of emergency-related research and development, and (2) efforts to increase user inputs to research and development plans and programs.

Because FEMA has a unique coordinating role within the federal structure with respect to all-hazards management, and because FEMA should have strong linkages to the local level, the Committee believes that FEMA should play an important coordinating role in the formulation of federal research and development objectives in emergency management.

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CHAPTER 4

PREVIOUS STUDIES ON SCIENCE AND TECHNOLOGY RELATED TO EMERGENCY MANAGEMENT

ANALYSIS OF PREVIOUS LITERATURE

What are the potentials for improving the contributions of science and technology to emergency management planning, hazard mitigation, and operations? This question has been addressed many times from a variety of different perspectives. The present chapter reviews the previous pertinent literature on this subject under three headings: (1) civil defense and national security, (2) an all-hazards approach, and (3) natural hazards.

Studies Oriented to Civil Defense and National Security

The impetus for many scientific and technical studies relating to emergency management developed from the need to protect the nation from the widespread destructive and disruptive consequences of a potential enemy attack with nuclear weapons. Beginning in 1950, with the establishment of the Federal Disaster Assistance Administration and the passage of the Federal Civil Defense Act, a major share of physical, biological, and social science research in emergency management focused on plans and preparations to defend civilians adequately against future wartime attack.*

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*Some of this research focused on the effects of biological and chemical attack and the protective measures needed to protect the civilian population from such attacks. But the bulk of it assumed that the enemy would use atomic or thermonuclear weapons.

One of the early efforts to assess this growing body of research was a report, published in 1958, on The Adequacy of Government Research Programs in Non-Military Defense by the Advisory Committee on Civil Defense of the National Academy of Sciences-National Research Council.[1] That publication evaluated federal research programs related to nonmilitary defense against nuclear attack and to recovery from such attack. The findings were based on the work of four subcommittees in the fields of nuclear radiation physics, biomedicine, the social sciences, and engineering. One of the seven basic conclusions of that study was that "much existing information and some resources are not effectively utilized; and the FCDA has usually been able to maintain effective coordination and integrated programs only in those areas where they have contracted for studies." In partially explaining that conclusion, the report stated: "Exchange of published reports does not usually provide sufficient or timely information. Frequent personal exchange of unpublished information at the working level, and symposia having the objective of disclosing the nonmilitary defense applications of current research, would greatly improve the present situation."

Again, in 1963, the National Academy of Sciences, under contract to the Office of Civil Defense, Department of Defense, was requested to examine the probable effects of enemy attacks on the United States and the problems of civil defense then and in the future. In response to this request, the Academy assembled a group of approximately 60 leading scientists and engineers drawn from universities, private industry, and governmental organizations for a six-week study session known as Project Harbor. The group considered the technologies of offensive and defensive

weapons systems as well as those relating to passive defense. Particular attention was directed to problems of immediate survival, long-range recovery, the political and psychological impact of various possible civil defense programs, and civil defense education and public acceptance. The final report of the study group, entitled Civil Defense: Project Harbor Summary Report,[2] generally concluded that any failures, then and in the foreseeable future, to ensure a higher degree of survival and a more rapid rate of recovery from attack by strategic weapons did not result from deficiencies or gaps in our technical knowledge. Rather, the primary needs were for more money for passive defense measures, wider application of existing technical knowledge, and more intensive research to support planning and program design.

The Education and Training Panel of the Project Harbor study suggested a comprehensive program for transferring scientific and technical knowledge to various audiences. This program included (1) the training of technical personnel; (2) adult education courses, job-connected orientation, general information disseminated via the mass media, and secondary school education to inform the general public; (3) the training of a professional civil defense cadre; (4) the training of a civil defense corps; and (5) the establishment of a national civil defense research center.

In November 1967 problems of postattack recovery were the subject of a four-day symposium jointly sponsored by the Office of Civil Defense, the Office of Emergency Planning, and the National Academy of Sciences through its Advisory Committee on Civil Defense and Advisory Committee on

Emergency Planning. The major objectives of the symposium were (1) to exchange information on the current state of knowledge in postattack recovery research; (2) to foster understanding within and among all the disciplines involved of the problems of the recovery period--their relative magnitude and importance, their difficulty, and the research needed to solve them; and (3) to give participants an opportunity to learn something about the problems and programs of disciplines other than their own. A total of 36 papers were presented on such subjects as sustenance, health, long-range biological and ecological effects, prospects for economic recovery, economics, and societal vulnerabilities. The information contained in the Proceedings of the Symposium on Postattack Recovery from Nuclear War[3] served for many years as a kind of benchmark for the subjects covered.*

In 1969 the Advisory Committee on Civil Defense of the National Academy of Sciences again reviewed the then-current national civil defense program and published A Critique of Some Technical Aspects of Civil Defense.[5] That report is notable in calling for a "total spectrum" approach to emergencies and disasters. One of its four major conclusions noted that civil defense research and other programs should be directed toward integrating civil defense, from the local level to the national level, into the peacetime structure for dealing with all types

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*The Federal Emergency Management Agency, in April 1981, sponsored a similar "Symposium on the Control of Exposure from Ionizing Radiation in the Event of Accident or Attack," conducted by the National Council on Radiation Protection and Measurements.[4] This symposium covered much the same ground as the 1967 symposium and was designed to update and build on the scientific and technical information from the earlier study.

of emergencies. It emphasized that protective plans and programs for nuclear attack should constantly be related to existing capabilities for handling lesser types of emergencies.

Studies Oriented to an All-Hazards Approach

The Federal Emergency Management Agency's current all-hazards approach to emergency management is largely rooted in past efforts to reconcile protective programs for wartime attack with peacetime federal, state, and local emergency responsibilities. It became apparent that the separation of emergencies into wartime and peacetime and natural and man-caused made no sense from the perspective of local emergency managers. The unnecessary waste and duplication caused by the federal fragmentation of emergency research by scientific and technical disciplines, by types of hazards or disasters, by time phases, and by jurisdictional definitions of federal agency missions also became clear. The luxury of such specialization is not permitted to those who bear daily responsibility for the functioning of the community or political jurisdiction over which they hold authority. Governors, mayors, police chiefs, fire chiefs, and other public officials must be prepared to handle the entire spectrum of hazards and emergencies that threaten the safety and well-being of the citizenry.

Recognition of these facts led a number of disaster research specialists to call for an interdisciplinary systems approach to emergencies that would view the field in generic terms. One of the first to study this problem was Robert U. Ayres, who was commissioned by the Advisory Committee on Emergency Planning of the National Academy of

Sciences, under contract to the Office of Emergency Planning (OEP), to examine in detail the research programs being carried out by federal agencies or outside contractors in direct or indirect support of the mission of the Office of Emergency Planning. His report, Review of Federally Sponsored Research Related to Emergency Planning,[6] published in 1967, provided an inventory of several thousand separate emergency-related projects, funded by dozens of federal departments and agencies, being conducted by hundreds of government, university, private, and commercial organizations. The projects selected for detailed review were discussed under 23 headings divided roughly into two broad categories: cause-oriented research and impact-oriented research. The first category included research on fires, severe storms, seismic and volcanic disturbances, floods, toxic environments, modern weapons, and other dangerous causal agents. The projects classified as impact-oriented were those concerned with the effects of various causal agents on particular objects or systems (cells, plants, animals, humans, physical structures, social organization, and such distributive networks as transportation, electrical power, and communications).

The general conclusion of the study was that peacetime disasters, which have a higher probability of occurrence than wartime emergencies, receive a proportionally inadequate amount of attention.

Ayres set forth five specific recommendations for the Office of Emergency Planning to consider. Of these, the following two are pertinent to the present study:

1. Establish an information retrieval system, using the existing Defense Documentation Center and Smithsonian Science Information

Exchange, as well as other sources, to provide a fairly complete and up-to-date compilation of pertinent research projects.

2. Establish a National Disaster Data Center as a central repository for information from many other government agencies with disaster responsibilities. The center would make this information available to qualified requestors, thus greatly facilitating disaster research and emergency planning.

A special subcommittee of the Advisory Committee on Emergency Planning was appointed in 1967 to examine the possible development by OEP of a National Emergency Center to coordinate the activities of the many existing groups and agencies responsible for disaster research, plans, and operations. The formation of this subcommittee was prompted by the belief within the Committee that emergency activities definitely needed a single focal point and, in part, by the Ayres report recommendation that a National Disaster Data Center be established.

The prospectus prepared by the subcommittee discussed the need for an emergency center, outlined its basic mission and functions, and suggested some ways to implement the concept.[7] The center was seen as having both operational and research functions, with a scope of attention that would eventually cover a wide spectrum of potential hazards and dangers to life, property, and social institutions. The subcommittee suggested three basic operational functions:

1. assistance to regional, state, and local agencies in disaster preparations.
2. hazard monitoring.
3. coordination of relief activities.

To carry out the operational functions of the center most efficiently, three major areas in which to coordinate and conduct research were outlined: (1) the causes and effects of disasters, (2) disaster operations, and (3) systems evaluation and planning.

One of the notable features of the subcommittee's report was its emphasis on a capability to provide immediate response--information, expert personnel, supplies, equipment, and money--to national, state, and local agencies confronted with urgent emergency problems. The report noted that this would require a sizable data bank of information available for rapid retrieval and the ability to hold teleconferences among personnel located at the disaster site, in the center, and elsewhere in the nation.

OEP subsequently used some of the foregoing ideas to seek a Presidential directive establishing a clearinghouse on emergency-related research. The President's message to Congress on disaster assistance of April 22, 1970, contained the following statement:

> Improvements in disaster assistance . . . require an improved program of research and evaluation, the results of which are readily available to all who can benefit from them. I have therefore directed the Office of Emergency Preparedness to act as a central clearinghouse for all Federal research which is related to disasters.

Following some preliminary efforts by the OEP staff to define the nature of such a clearinghouse, Charles E. Fritz, then a staff member of the Institute for Defense Analyses, was commissioned to conduct a study

that would guide the establishment of the clearinghouse. In 1971 he produced a two-volume report, Some Guidelines for Developing an Office of Emergency Preparedness Clearinghouse for Emergency-Related Research.[8] That study reviewed the previous studies and analyses of the development and operation of such a clearinghouse; discussed the major problems and deficiencies in the then-current emergency research and its use, inventoried and described the various research centers, agencies, and data sources that could provide useful information and services; and concluded with a set of general and specific guidelines for the development and operation of the clearinghouse.

The report outlined a series of specific functions and tasks for the clearinghouse in emergency research and the application of research findings to the needs of users. These tasks included use of existing computerized data banks, such as the National Technical Information Service and the Smithsonian Science Information Exchange, to identify and monitor past and current research studies of significance to various users; the development and maintenance of a comprehensive directory of specialists who have expertise in various areas pertaining to hazards and disasters; and the publication of a special newsletter to facilitate communication among scientific and technical disciplines and between the research-oriented communities and those people who develop, administer, and operate practical programs. The report also suggested that the clearinghouse serve as a central point of contact for the exchange of emergency-related information between the United States and other nations, and between the United States and the various international organizations; that it serve as a source of accurate summarized

information on scientific aspects of disasters and hazards for the mass media; that it assess the current state of scientific knowledge to identify unnecessary duplications, critical gaps in knowledge, and research areas that offer unusual promise of scientific and social benefit; that it consider organizing a White House conference on disasters and other emergencies; that it encourage the development of new techniques for translating scientific and technical findings to meet the needs of users; and that it develop a capability for rapidly polling experts on various subjects to obtain quick scientific and technical advice on urgent policy and operational problems.

The Office of Emergency Preparedness took some initial steps to establish a clearinghouse, but OEP itself was disestablished in 1973 and split into three separate parts under three different agencies. Subsequently, only one of the suggestions made in Fritz's report was implemented. This was the publication of a Directory of Disaster-Related Technology in 1975 by the Federal Disaster Assistance Administration (FDAA) of the Department of Housing and Urban Development.[9] The directory was prepared by Ugo Morelli and Maria del Sart of the Preparedness Division of FDAA, under the general supervision of Robert Schnabel. It is a compendium of studies, investigations, and research efforts undertaken during the period 1970 to 1975. Its stated purpose was to improve the application of disaster-related technology by federal, state, and local governments and the private sector through the exchange of information from recently completed and current research. It was hoped that such applications would be made in legislation, land use

planning and regulations, building standards and codes, design and construction practices, emergency planning and operations, and other measures of disaster mitigation.

In 1977 the National Governors' Association (NGA) set up a Subcommittee on Disaster Assistance, under the chairmanship of Nevada Governor Mike O'Callaghan, a former regional director of the OEP. The subcommittee undertook two major activities: (1) to study and subsequently support the President's establishment of an independent Federal Emergency Management Agency (FEMA), and (2) to make a comprehensive one-year study of the states' problems in managing all types of emergencies, with resulting recommendations.[10]

In its meeting of February 28, 1978, the NGA unanimously passed a three-page resolution that urged the President to reorganize the existing federal responsibilities for emergency preparedness and disaster relief of the Defense Civil Preparedness Agency, the Federal Disaster Assistance Administration, and the Federal Preparedness Agency into one agency, either as a part of the Executive Office of the President or as an independent agency. With the actual establishment of FEMA along the lines that the NGA had recommended, attention was turned to the second activity: establishing the NGA State Emergency Preparedness Project under the direction of Hilary Whittaker. Recognizing the need to review state operations in the context of viable federal emergency management, the NGA directed this study to analyze current state emergency operations for all types of emergencies and recommend options for comprehensive management.

The results of the project's detailed surveys of the states, commonwealths, and territories showed that many, if not most, state

emergency management programs are fragmented; that mere preparedness and response mechanisms are not good enough, but they should be coordinated with active mitigation and long-term recovery programs in the context of state development; that planning, program development, and political skills, as well as response skills are needed in emergency management; that many state and federal officials believe mitigation programs can save lives and dollars; and that states should augment their capacities to deal with man-made emergencies with fuller use of existing personnel and resources.

The project developed the concept of Comprehensive Emergency Management (CEM), in which disasters are clustered into four phases that have a temporal and functional relation with disaster agents: mitigation, preparedness, response, and recovery. The final report of the NGA State Emergency Preparedness Project recommended that governors appoint a Comprehensive Emergency Manager who would oversee all four phases of all-hazard emergencies at every public and private level. It was also noted that state emergency organizations should develop programs and operational guidelines for five distinctively different types of emergencies: attack (conventional or nuclear), internal disturbances, natural disasters, technological emergencies, and energy and naterials shortages.

The report recommended that federal and state agencies should collaborate in developing of a central information clearinghouse to provide state-of-the-art knowledge on technical and managerial aspects of CEM; that all levels of government should share more information about their resources and approaches to emergency management; and that CEM

strategies should develop more direct communication and information links between emergency sites and CEM decision centers, among government units, and between governments and the private sector. Two recommendations pertain directly to FEMA: federal officials, especially those who operate in the regions or the states, should receive better training and orientation in the problems, resources, and methods of state governments; and federal agencies (FEMA) should provide grants to educate and orient state and local officials in the concepts and principles of CEM.

Studies Oriented to Natural Disasters

In recent years there have been a number of broad-gauge studies aimed at assessing the state of the art in scientific and technical research on natural disasters and on how effectively knowledge of those types of disasters is being applied. Their distinguishing feature is their exclusive focus on those emergencies and disasters produced by the forces of nature, and they therefore exclude consideration of man-caused or technology-induced peacetime and wartime emergencies.

One of the first comprehensive efforts of this type was the Report to Congress: Disaster Preparedness, a three-volume study prepared by a special OEP Disaster Study Group, directed by Robert F. Schnabel, in January 1972.[11] This study responds to a congressional directive for a full and complete investigation to determine what additional improvements could be made to prevent or minimize the loss of life and property due to major disasters.

The study examined in detail ten types of natural disasters: river floods, tornadoes and windstorms, hurricanes and storm surges, forest and

grass fires, earthquakes, landslides, tsunamis, volcanoes, frosts and freezes, and droughts. Particular attention was given to (1) vulnerability, (2) prediction and warning capabilities, (3) preventive measures, and (4) preparations and readiness for governmental and public response to disasters.

A major part of the report is devoted to the application of science and technology to disaster prevention, mitigation, and preparedness. This part comprises a broad examination and overall assessment of current actions and opportunities for developing a more coherent, coordinated, and comprehensive program of science and technology applied to reducing losses that result from natural disasters.

Findings of this study include the following:

1. The most immediate need in the field of disaster research is to apply more effectively what is already known. This requires a better exchange of information and greater mutual understanding among the sciences, public officials, and the public itself.

In discussing this finding, the report suggested implementing the OEP disaster research clearinghouse and establishing a program of symposia and conferences with interdisciplinary participation.

2. An interdisciplinary approach to disaster research is recognized as essential in developing coherent and comprehensive disaster prevention, mitigation, and preparedness programs.
3. There is no one place or organization in the United States that is designated and chartered to bring together the many specialized research results to form an interdisciplinary approach to improving disaster prevention, mitigation, and preparedness.

The report suggested a study of the desirability and practicability of establishing a National Center for Disaster Research, which could have the following responsibilities: to serve as a more encompassing disaster research clearinghouse; to include private as well as governmental research activities; to provide interconnections among the many specialized disaster research laboratories and centers throughout the nation; to sponsor and conduct interdisciplinary disaster research; to coordinate on-the-scene scientific research and evaluations following major disasters; to formulate recommendations for improved measures of disaster prevention, mitigation, and preparedness; to provide a center for professional development of disaster program officials and visiting scholars; to publish a professional journal; to assist in fostering U.S. interests in international activities related to disaster research; and to undertake special studies directed by the President and the Congress.

The report also strongly recommended an improved program of disaster evaluation, as the connecting link between new knowledge, acquired through experience and research, and improved disaster preparedness. It called for a combination of predisaster and postdisaster observations and assessments, including on-the-scene evaluation, postdisaster critiques, predisaster exercises and critiques, and preparedness and performance evaluations of state and local emergency organizations.

The results of a major two-year study on natural hazards research and applications, conducted by the Institute of Behavioral Science at the University of Colorado, are summarized in the book Assessment of Research on Natural Hazards by Gilbert F. White and J. Eugene Haas, published in 1975.[12] The study had two broad aims: (1) to provide a more nearly

balanced and comprehensive basis for judging the social utility of allocating funds and personnel for various types of research on geophysical hazards; and (2) to stimulate, in the process of that analysis, a more systematic appraisal of research needs by scientific investigators and the users of their findings.

The study identified a need for redirecting federally funded activities related to natural hazards away from heavy concentration on technologically oriented solutions to an equal focus on the social, economic, and political factors that lead to nonadoption of technological findings or that indicate proposed steps that will not work or will only tend to perpetuate the problem. The report called for a better balance between the social, economic, and political factors and the physical and technical factors.

Among the research strategies recommended to improve the conduct and applications of research, the report referred to:

1. Postdisaster audits. A systematic program to examine what happens when a major disaster occurs.
2. Longitudinal studies. Long-term studies of how communities and families prepare for and recover from major disasters.
3. Clearinghouse service. A center to ensure rapid and wide circulation of information and judgment among the producers and users of research and to provide immediately available information on current research findings for local and state planners.

The report also gave specific recommendations for high-priority research and the cost of this research for 15 different types of

hazards: hurricane, flood, tornado, lightning, hail, windstorm, frost, urban snow, earthquake, tsunami, landslide, snow avalanche, [illegible]tal erosion, drought, and volcano.

In a separate chapter on application of research, the report reviews some of the past successes and failures in the application of emergency research and outlines the characteristics associated with effective application of research findings. The report emphasizes the desirability of establishing personal relationships between users and researchers prior to the completion of a final report. And it notes that the possibility of developing such relationships between research producers and users adds weight to the argument for some kind of clearinghouse in which these groups could come together periodically to discuss needs and findings before formal reports are completed.

In a recent Appraisal of the Status of Natural Hazards Research,[13] by the Natural Hazards Research and Applications Information Center at the University of Colorado, published in June 1981, the major recommendations made in Assessment of Research on Natural Hazards, which covers the period 1973-1974, are combined with recommendations contained in 11 reports issued between 1974 and 1980. In addition, over 100 other research reports are covered in determining the progress that has been made in carrying out recommended research and applications. The paper covers common research themes on the subjects of warning systems, land use management, technological adjustments, relief and rehabilitation, insurance, postdisaster audits, hazards data management, a clearinghouse service, comprehensive state studies, congressional overview, the mass media, disaster response, and risk assessment. It then assesses progress

(or lack of progress) in dealing with the aforementioned 15 specific hazards (hurricane, flood, lightning, etc.).

The general conclusion from this appraisal is that progress in implementing recommendations on disaster research is very spotty. In some areas significant advances have occurred; in others the research findings have been partially implemented or totally ignored.

One of the major current efforts to apply scientific and technical knowledge to hazard mitigation, preparedness, response, and recovery derives from the passage of the Earthquake Hazards Reduction Act of 1977 (Public Law 95-124). The legislation states that "It is the purpose of the Congress in the Act to reduce the risks to life and property from future earthquakes in the United States through the establishment and maintenance of an effective earthquake hazards reduction program." As a first step the legislation directed the President to develop an implementation plan with year-by-year targets through at least 1980, and it recommends appropriate roles for state and local units of government, individuals, and private organizations in carrying out the implementation plan. This responsibility was assigned to the Office of Science and Technology Policy, which in 1978 published its report Earthquake Hazards Reduction: Issues for an Implementation Plan.[14] The report identifies and discusses 37 issues involved in implementing the program. These 37 issues are grouped under the following headings: preparedness and response planning, earthquake prediction and warning, earthquake hazards reduction through construction programs, private and public financial institutions, land use planning and its implmentation, and communication and education. The report strongly emphasizes the need to translate and

disseminate scientific and technical knowledge on earthquakes to professional groups, to public officials, to the mass media, and to the public at large through existing institutional mechanisms (e.g., public and private schools, professional societies, and public interest groups). One of the key recommendations refers to the need for a national disaster information center:

- o A national center for disaster-information dissemination is badly needed. This center should be sensitive to user needs, and should emphasize linking users with existing sources of information rather than developing a duplicative archive. It should be highly operationally oriented and emphasize personal retrieval rather than hard-copy retrieval systems. It should have a small staff of research utilization specialists.

In April 1978 the Natural Hazards Research and Applications Information Center at the University of Colorado sponsored a three-day workshop, funded by the U.S. Geological Survey and the National Oceanic and Atmospheric Administration, to (1) discuss measures to improve current systems of data collection, (2) identify changes in recording and storage methods that might make data more useful, and (3) suggest cooperative agreements between agencies collecting similar data. The results of that workshop were subsequently published in a document entitled Natural Hazards Data Resources: Uses and Needs, edited by Susan K. Tubbesing.[15]

The first day of the workshop provided an opportunity for data users to share their appraisal of the adequacy of existing data resources with

a number of federal agency personnel responsible for collection and storage of hazards data. The second day was devoted to consideration of simulation and data mapping as ways to improve the application of data to natural hazards management. First, a possible national simulation model with geographical coordinates was discussed. Attention then turned to three spatial information systems currently operating at the local and regional levels that are being used or have the potential to improve planning and response to extreme natural events.

The concluding day of the workshop was devoted to the drafting of a set of recommendations to improve the usefulness of hazards data resources, which increases the effectiveness of activities designed to enhance mitigation and ultimately reduces hazard-related losses. The following nine recommendations were developed through the papers presented at the workshop and the subsequent discussion:

1. The new Federal Emergency Management Agency should take on the responsibility to facilitate the exchange and use of hazards information.
2. Guidelines should be established to coordinate mobile monitoring of meteorologic, seismic, and geologic conditions in the predisaster situation. This effort should be the responsibility of the National Oceanic and Atmospheric Administration (NOAA) and the U.S. Geological Survey (USGS).
3. Guidelines should be established for aerial photography, remote sensing, and ground surveys to be carried out in the immediate

postdisaster situation, coordinated by the Federal Disaster Assistance Administration.*

4. The Federal Disaster Assistance Administration should establish an interagency task force to evaluate existing data bases; to identify areas of data incompatibility, possible duplication, and/or omission, and to suggest ways for improving natural hazards data bases.
5. The U.S. Geological Survey should, within the next year, develop a national program to identify and delineate geologically related hazards (earthquake, volcano, landslide, and subsidence) and a strategy for implementing such a program using all federal, state, academic, and private resources as appropriate. Such a program, in conjunction with NOAA's National Geophysical and Solar Terrestrial Data Center's hazard delineation activities, would provide a basis for natural hazard identification, delineation, and risk assessment.
6. The design of national simulation models should be undertaken, using interagency data and technical assistance, and coordinated by FEMA.
7. The draft inventory compiled in preparation for the Natural Hazards Data Resources Workshop by Robert Alexander of USGS and James Lander of NOAA should be completed and distributed among

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*The Federal Disaster Assistance Administration no longer exists as a separate entity. It was absorbed into the Federal Emergency Management Agency when the latter agency was established in 1979.

user groups. The inventory should be designed as a problem-oriented instructional booklet, using an attractive technical assistance format.

8. The Federal Disaster Assistance Administration should reexamine the 1971 inventory in Some Guidelines for Developing an Office of Emergency Preparedness Clearinghouse for Emergency-Related Research, Volume II, Appendix C, which was prepared for the former Office of Emergency Preparedness by Charles E. Fritz, to determine the availability and nature of natural hazards data sources that are maintained by organizations in the private sector.

9. To facilitate the transfer of existing information on natural hazards planning and improve awareness of natural disasters on the part of state and local officials, the federal government, under the leadership of FEMA or existing preparedness agencies and with the support of other appropriate federal agencies, should undertake a training program for the use of hazards data by local, regional, and state groups that have responsibility for risk assessment, disaster avoidance, mitigation, response, and recovery.

The draft inventory referred to in recommendation 7 was completed by James F. Lander, Robert H. Alexander, and Thomas E. Downing and published jointly by the National Oceanic and Atmospheric Administration and the U.S. Geological Survey in May 1979 under the title Inventory of Natural Hazards Data Resources in the Federal Government.[16] The inventory contains over 100 data sources covering 13 major natural hazards: avalanche, drought, earthquake, erosion, flood, landslide, lightning, severe storm, tornado, tropical cyclone, tsunami, volcano, and wildfire.

The report devotes a single summary sheet to each data resource, giving the following elements of information: descriptive title; agency and location; synopsis of content (with a description of the data resource, including topics in the data, level of aggregation, geographic area covered, time period of record, and sources of data); format (structure of resource, including available media or formats--computer-compatible, printed, graphic--available services related to data, costs of acquiring data, frequency of updating resource, restrictions of access, and location of data); reference (including published reports, users' guides, and articles or pamphlets describing available data); and contact person (including address and telephone number).

CONCLUSIONS AND RECOMMENDATIONS FROM PREVIOUS STUDIES

This review of previous studies of science and technology relating to emergency management has revealed a number of common themes. These are briefly summarized below:

Use of Scientific and Technical Knowledge

- There is a clear need to use scientific and technical findings more effectively in emergency mitigation, preparedness, response, and recovery programs and operations.
- Priority should be given to the more effective use of existing scientific and technological knowledge in emergency management, rather than to initiating new research programs.

- o Scientists and engineers need a better understanding of emergency managers' needs.
- o Emergency managers need to make fuller use of the many existing computerized data bases in retrieving scientific and technical information relevant to their plans and programs.

National Emergency Clearinghouse

- o A federally sponsored national emergency clearinghouse is clearly needed to serve as the focal point for the assessment of research needs and for the collection, translation, and dissemination of information relevant to emergency management. Such a clearinghouse should have the capability to apply science and technnology quickly to urgent emergency situations by contacting experts who can provide advice on the spot or by setting up teleconferences with emergency personnel at the site of operations.

Translation and Dissemination of Scientific and Technical Information

- o There is an urgent need to translate emergency-related scientific and technical knowledge into language understandable to various user groups. This may require the recruitment and training of intermediaries skilled in such translations.

- In disseminating scientific and technical knowledge to various user groups, existing educational institutions--including public and private schools at all levels, professional schools and societies, public interest groups, etc.--should be fully used.
- Broadly based public information programs are needed to educate people about the various hazards and disasters and about what they personally can do to prevent or minimize threats to their health, welfare, and property. Such educational programs should be tailored to the particular needs of various audiences. Particular attention needs to be devoted to educating emergency managers and the public about radiation dangers and protective countermeasures.

Policy Emphases

- The emergency management community should place greater emphasis on mitigation and preparedness measures and on the scientific and technical knowledge pertaining to those measures (as contrasted with the greater emphasis on response and recovery in the past).
- Because the locality is the most important component of the emergency management system, special efforts should be made to provide scientific and technical assistance to emergency

managers at that level. This will require new efforts to assess needs at this level and, where necessary, to redirect current and future research efforts to meet these needs.

Research Emphases

- o An all-hazards approach to emergency management requires the use of a broad, interdisciplinary systems analysis perspective and methodology by scientists, engineers, and policy analysts.
- o Future emergency-related research should seek to better balance social, political, and economic factors with physical and technical factors.
- o There is a need to evaluate the effectiveness of various methods of disseminating scientific and technical knowledge to professional groups and the general public.

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APPENDIX A

BIOGRAPHICAL SKETCHES OF COMMITTEE MEMBERS, SPECIAL CONSULTANT, AND STAFF

CHARLES K. ALLEN is Director of Public Affairs and Safety for the City of Plainfield, New Jersey. He serves as the Director of Emergency Management for the Municipality and supervises and directs the programs and activities of the Fire Division, Police Division, Division of Signal Systems, Health Division, Division of Welfare, Division of Recreation, and Division of Inspection. His educational background includes undergraduate work at New York University in the School of Commerce, graduate work in the School of Public Administration, and additional graduate work at Rutgers University in the School of Criminal Justice. He was formerly the Director of the Model Cities Program in Jersey City, New Jersey, and Supervising Community Service Officer for the State of New Jersey. He is a member of numerous professional and civic organizations, including the United States Civil Defense Council, the New Jersey Emergency Management Association, the National Organization of Black Law Enforcement Executives, and the International Association of Chiefs of Police. He is also a member of the Advisory Boards of the American Red Cross and the Salvation Army.

JOHN A. AUXIER is Director of the Industrial Safety and Applied Health Physics Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee. He received his B.S. degree in Physics from Berea College in 1951, his M.S. in Physics from Vanderbilt University in 1952, and his Ph.D. in Nuclear Engineering from the Georgia Institute of Technology. Dr. Auxier has been a pioneer in health physics and radiobiology. He conducted research on the survivors of the atomic bombings of Hiroshima and Nagasaki. His reports on this research, widely cited in the literature, include Ichiban: Radiation Dosimetry for the Survivors of the Bombings of Hiroshima and Nagasaki and Free Field Radiation--Dose Distribution from the Hiroshima and Nagasaki Bombings. He is the recipient of several professional awards, including the National Institute of Disaster Mobilization Award in 1962 and the Anderson Memorial Award from the Health Physics Society in 1963. He was a member of the National Academy of Sciences Advisory Committee on Civil Defense and of its subcommittee on shielding. He is a member and has served on various committees of the National Council on Radiation Protection and Measurement and numerous other national and international task groups and committees concerned with physics and radiation protection. He is currently serving as national and international consultant to the Radiation Effects Research Foundation, a binational organization funded jointly by the United States and Japan to continue studies of the radiation effects of Hiroshima and Nagasaki survivors.

ROBERT L. CHARTRAND is a Senior Specialist in Information Policy and Technology, Congressional Research Service, Library of Congress, in Washington, D.C. He received his B.A. degree from the University of Missouri in 1948 and his M.A. in 1949, followed by additional postgraduate work at Louisiana State University. Before joining the Congressional Research Service in 1966, he was an intelligence specialist with the U.S. Navy, a member of the technical staff of the Ramo-Woolridge (TRW) Company, Manager of Advanced Systems Marketing with IBM's Federal Systems Division, and Manager of Applications Development for the Planning Research Corporation. Mr. Chartrand is a widely recognized expert in information transfer technologies and the application of automatic data processing to the solution of problems in business, government, and urban communities. He is the author of numerous books and professional journal articles on these subjects. He is also the author of 10 major congressional reports. He served as a consultant to the President's Commission on Population Growth and the American Future and to the National Commission on Civil Rights. He was decorated with the Cavaliere Officiale award by the Government of Italy; he is a recipient of an award from the Interagency Committee on Automatic Data Processing; he is a Fellow of the American Association for the Advancement of Science; and he serves as a member of the Advisory Board for the publication Hazard Monthly. He currently serves as a consultant to and hearings coordinator for the Subcommittee on Investigation and Oversight of the House Committee on Science and Technology.

HENRY C. HUNTLEY has had a long and distinguished career in the fields of public health and emergency medical services. He received his A.B. degree in 1933 and his M.D. degree in 1937 from Washington University in St. Louis, Missouri. He received the Master of Public Health degree in 1949 from the University of Michigan. He was Regional Director of Federal Civil Defense Administration Region 2 from 1953 through 1955. Subsequently he held the positions of Health Programs Consultant to the Public Health Service's Region 2, Regional Health Director of HEW Region 2 in Boston, Assistant to the Surgeon General for Appalachian Regional Planning, and the Director of Emergency Health Services. His last position prior to retiring as a private consultant was Administrator of Preventive Health Programs and Emergency Medical Services for the State of Florida Health Department. Dr. Huntley has served as a member of the American Board of Preventive Medicine, the Association of Military Surgeons, and the American Medical Association and its Committee on Emergency Medical Services. He is a past President of the American Association of Public Health Physicians, a Fellow of the American Public Health Association, a board member of Medic Alert International and of the National Coalition for Disease Control and Environmental Health, a consultant to the U.S. Civil Defense Council, and an Advisory Editor for the journal Emergency Medicine. He has written numerous articles on the subject of emergency medical preparedness and is the recipient of the meritorious service award from the Public Health Service, the Pfizer Award of Merit for the U.S. Civil Defense Council, an AMA Award of Appreciation for his service on the Committee on Emergency Medical Services, and the Distinguished Service Medal of the American Association of Public Health Physicians.

EDWIN KESSLER is Director of the National Severe Storms Laboratory, National Weather Service, Norman, Oklahoma. He received his A.B. degree from Columbia University in 1950 and his S.M. and Sc.D. degrees from the Massachusetts Institute of Technology in Meteorology in 1952 and 1957. He was a research meteorologist at the Weather Radar Branch, Air Force Cambridge Research Center, from 1954 to 1961, and was Director of the Atmospheric Physics Division, Travelers Research Center, from 1961 to 1964. He assumed his present position in 1964 and has served concurrently as Adjunct Professor at the University of Oklahoma. He also was Visiting Professor at MIT in 1975-76 and visiting lecturer at McGill University in 1980. He is a fellow of the American Association for the Advancement of Science and of the American Meteorological Society and a member of the American Geophysical Union and the Royal Meteorological Society. His research interests center on a synthesis of varied observations and theory to improve understanding of meteorological phenomena, and he has authored about 100 reports and publications on meteorological, agricultural, and ecological topics. Dr. Kessler has served on several AMS Committees and on several NAS-NRC committees and panels, including the Geophysical Predictions Panel of the Geophysics Study Committee, Geophysics Research Board, and the Panel on Precipitation of the Committee on Atmospheric Sciences. He is currently serving as a member of the Committee on Natural Disasters, whose activities include the dispatch of teams to collect engineering information after a natural disaster and the publication of a report on each site visit.

GEORGE G. MADER, Vice President of William Spangle and Associates, Portola Valley, California, has had extensive experience in the application of urban planning principles to the analysis and implementation of hazard mitigation programs. Mr. Mader received a B.A. degree in geography in 1952 from the University of California at Los Angeles and a Master of City Planning degree in 1956 from the University of California at Berkeley. In 1958 he was awarded a Fulbright Scholarship and spent a year at the Technological University at Delft in the Netherlands studying city planning in Western Europe. From 1955 to 1962 he served as an associate planner on the staff that prepared the San Mateo County general plan and as senior planner in charge of the current planning division for the San Mateo County Planning Commission. In 1962 Mr. Mader joined William Spangle and Associates. His work has included developing new plans and regulations responsive to geologic and seismic hazards. He has worked extensively with earth scientists in planning activities and was a participant in the San Francisco Bay Region study of the use of earth science information in land use planning. He recently completed a two-year NSF-funded study of postearthquake land use planning. His written articles have appeared in numerous planning and earth science publications. He was formerly Chairman of the Advisory Group on Land Use Planning to the Joint Committee on Seismic Safety, California Legislature. He has been a member of the California Seismic Safety Commission since its formation in 1975 and was elected as chairman in 1979. He is a member of the Governor's Emergency Task Force on Earthquake Preparedness in California. From 1977 to 1978 he was a member of the Advisory Group on Earthquake Ha ards Reduction for the President's Office of Science and Technology Policy. He has taught city and regional

planning courses at the University of California and since 1970 has been on the staff of the School of Earth Sciences at Stanford University, where he teaches courses in the planning application of earth science information. He is a member of the American Planning Association and the Institute of Certified Planners and has held offices in the Northern California Section and the California Chapter of AIP. Mr. Mader also currently serves as a member of the Advisory Board for the publication Hazard Monthly.

ROBERT W. MORSE, Chairman of the Committee on Emergency Management, is currently Senior Scientist at the Woods Hole Oceanographic Institution, Woods Hole, Massachusetts. He received his B.S. degree from Bowdoin College in 1943 and his Sc.M. and Ph.D. in Physics from Brown University in 1947 and 1949, respectively. He served as a naval officer from 1943 to 1946. From 1949 to 1962 he served as Assistant Professor to Professor of Physics and Departmental Chairman at Brown University. He was Dean of Brown University from 1962 to 1964. He served as Assistant Secretary of the Navy for Research and Development from 1964 to 1966. He was President of Case Institute of Technology from 1966 to 1967 and was President of Case Western Reserve University from 1967 to 1971. He joined the Woods Hole Oceanographic Institution in 1971 as Director of Research and later served as Associate Director and Dean of Graduate Studies. His primary research interests have centered on the subjects of ultrasonics, electronic properties of metals, cryogenics, and underwater sound. He has been a chairman and member of numerous NAS-NRC boards, committees, and panels. He has served as chairman of the following: Committee on Undersea Warfare, Board on Human Resources, Ocean Affairs Board, and the Panel on National Needs for Synchrotron Radiation Facilities. His memberships in various units of the NAS-NRC include the following: Naval Research Advisory Committee, Committee on Maritime Industry Opportunities from Development of Ocean Resources, Navy Oceanography Program Review Steering Committee, and Panel on Solid State Sciences of the Division of Physical Sciences. He received an honorary Sc.D. degree from Bowdoin College in 1966. He is a Fellow of the American Academy of Arts and Sciences, of the American Physical Society, and of the Acoustical Society of America. He served as the President of the latter society in 1965-66 and was chairman of the Division of Solid State Physics of the American Physical Society from 1960 to 1962. Dr. Morse is currently chairing another NAS-NRC committee: the Committee to Evaluate Enewetak Radioactivity Containment.

RONALD W. PERRY is a Research Scientist with the Battelle Human Affairs Research Centers in Seattle, Washington. He received his B.S. degree in Sociology and Anthropology and his M.A. in Sociology and Computer Science from Arizona State University in 1971 and 1973, respectively. He received the Ph.D. degree in Sociology and Social Psychology from the University of Washington in 1975. His principal specialties include the study of social change (including emergency preparedness policy analysis, social system stress, and community structure and organizations); social psychology (including human behavior in disaster, community psychology, attitudes, and social behavior); and research methods and statistics (including evaluative research, survey methodology, and measurement and

scaling). Dr. Perry has conducted many empirical and analytic studies relating to both natural and technology-induced emergencies and disasters. His published reports and articles cover such subjects as the psychological consequences of natural disasters, the detection of psychopathological reactions to disaster, emergency response in transportation of radioactive materials, nuclear facility guard force performance in emergencies, human response to the volcanic eruption of Mount St. Helens, and disaster warning response and large-scale evacuation of threatened populations. His professional activities have included membership in the King County Mental Health Board, Seattle, Washington; and membership in the Office of Military Affairs Assessment Team, Office of the Assistant Secretary for Defense Programs, U.S. Department of Energy. He is also a member of Delta Tau Kappa, the international social science honor society; Alpha Kappa Delta, the national sociology honor society, the American Sociological Association, the American Psychological Association, the Pacific Sociological Association, and the Society for the Study of Social Problems.

ROBERT S. WILKERSON is Director of the Division of Public Safety Planning and Assistance, Department of Veteran and Community Affairs, in the State of Florida. In that position he serves as Florida's principal coordinator for comprehensive emergency management. This includes responsibility for the development of programs and capabilities within state and local agencies for hazard mitigation, preparedness, response, and recovery, and coordination of these programs with federal programs, volunteer agencies, and private enterprise. His past experience includes some 14 years in public administration, planning, and management systems. He holds a B.S. degree from the Auburn University School of Engineering and an M.S. degree in Urban Planning for Florida State University. He has been responsible for such varied tasks as coordination of state response to hazardous materials spills, coordination of hazard mitigation efforts, liaison with the insurance industry, and liaison with federal agencies. He has served on the National Task Force on Comprehensive Emergency Management Planning, as the Executive Director of the First National Conference on Hurricanes and Coastal Storms, and as Chairman of the Regional Task Force on Guidelines for Local Comprehensive Management. He has also served as a speaker for a number of groups, including the International Conference on Hazardous Waste Management, the National Highway Safety Program, and the American Insurance Association.

SPECIAL CONSULTANT

ROBERT J. ADAMCIK is the Acting Regional Director of the Federal Emergency Management Agency's Region III, located in Philadelphia and comprising the states of Pennsylvania, West Virginia, Virginia, Delaware, Maryland, and the District of Columbia. A native of Pennsylvania, Mr.

Adamcik holds a degree in civil engineering from the University of Cincinnati and is a registered professional engineer in Pennsylvania. Prior to his present appointment, he was the Regional Director of the Federal Disaster Assistance Administration (FDAA) Region III in Philadelphia. He represented the Administrator of FDAA in all matters pertaining to the administration of the President's Disaster Relief Act of 1974, Public Law 93-288. Prior to his appointment as Regional Director, he served as Program Officer with FDAA and the Office of Emergency Preparedness in Washington, D.C. for five years. In that capacity he assisted in the development, coordination, and organization of policy, procedures, and project administration. During the Three Mile Island nuclear power plant accident in Pennsylvania, Mr. Adamcik was named by the President as the "Lead Federal Official" to work with the Governor and to coordinate the efforts of federal and state agencies in planning for the mass evacuation of the population and other emergency contingency responses that might have been needed if there had been a more dangerous escape of radioactive materials from the power plant. Mr. Adamcik has served as the Federal Coordinating Officer during a number of natural disasters throughout the country. Before joining the federal government he was Engineering Vice President with Detweiler Associates and Project Engineer and Director of Data Processing with Berger Associates. He served as an officer with the U.S. Army Corps of Engineers.

STAFF

CHARLES E. FRITZ, Executive Secretary of the Committee on Emergency Management, has had over 30 years of experience in the study of human and organizational behavior under emergency and disaster conditions. He received his B.A. degree from Drury College in 1942 in Sociology, and his M.A. in the same field from the University of Chicago in 1950. He had additional studies toward the Ph.D. at the University of Chicago from 1950 to 1952. His active duty tour with the U.S. Army Air Corps during World War II included participation in the U.S. Strategic Bombing Survey in Europe. From 1950 to 1954 he led a team of 25 behavioral scientists in conducting field studies of major disasters occurring throughout the United States for the National Opinion Research Center, University of Chicago. This culminated in the preparation of a three-volume report on "Human Reactions to Disaster Situations." In 1954 he joined the staff of the Committee on Disaster Studies, National Academy of Sciences-National Research Council, as a Research Associate. He subsequently became Assistant Director of the NAS-NRC Disaster Research Group. From 1959 to 1962 he was Associate Professor and Director of the Behavioral Science Research Division, Department of Psychiatry, University of Florida College of Medicine, and held a concurrent appointment in the Department of Sociology and Anthropology. From 1962 to 1971 he was a Research Staff Member of the Institute for Defense Analyses, conducting research on the functioning of the U.S. military command and control system in actual domestic and international crises. In 1971 he rejoined the National Academy of Sciences as Executive Secretary of its Advisory Committee on

Emergency Planning. Subsequently he has served as Executive Secretary of the following NAS-NRC units: Panel on the Public Policy Implications of Earthquake Predictions, Committee on the Socioeconomic Effects of Earthquake Predictions, Committee on Disasters and the Mass Media, Committee on U.S. Emergency Preparedness, and Committee on International Disaster Assistance. He is the author or co-author of over 40 publications pertaining to emergency research. Other professional activities relating to emergencies and disasters include: member, NAS-NRC Committee on Emergency Planning and Chairman of its Subcommittee on the National Emergency Center, 1966-71; member, Subcommittee on Communications, NAS-NRC Committee on Emergency Medical Services, 1969-71; and member, NAS-NRC Committee on Civil Defense and Chairman of its Subcommittee on Organization and Operation of Civil Defense Systems, 1966-70. He was a member of the Senior Consultants Group, President's Reorganization Project, Office of Management and Budget 1977-78, and a member of the Advisory Group, Office of Science and Technology Policy, Working Group on Earthquake Hazards Reduction, 1977-78. He is currently a member of the following groups: NSF Advisory Subcommittee on Earthquake Hazards Mitigation; NSF Advisory Subcommittee on Civil and Environmental Engineering; Advisory Committee on Natural Disaster Mitigation and Recovery, The Academy for Contemporary Problems; and the Advisory Board of the publication Hazard Monthly.

APPENDIX B

CENTRALIZED SOURCES OF SCIENTIFIC AND TECHNOLOGICAL INFORMATION RELATING TO EMERGENCY MANAGEMENT

Note: An asterisk in front of a given reference indicates a source of special usefulness.

GENERAL DIRECTORIES IN PRINT

Ann Massie Case (ed.), Bibliographic Index, A Cumulative Bibliography of Bibliographies, 1980 (New York: T. W. Wilson Company, 1981.)

*Ruth N. Cuadra, David M. Abels, and Judith Wanger (eds.), Directory of Online Databases (Santa Monica, California: Cuadra Associates, Spring 1981).

Irregular Serials and Annuals: An International Directory, 6th ed., 1980-1981 (New York: R. R. Bowker Company, 1980).

Subject Guide to Books in Print, 1980-1981 (New York: R. R. Bowker Company, 1980).

Ulrich's International Periodicals Directory (New York: R. R. Bowker Company, 1980).

*U.S. General Accounting Office, Federal Information Sources and Systems 1980 (Washington, D.C.: U.S. Government Printing Office, 1981). Describes federal sources and information systems maintained by executive agencies, which contain fiscal, budgetary, and program-related data and information.

*Martha E. Williams and Sandra H. Rouse (eds.), Computer-Readable Bibliographic Data Bases (Washington, D.C.: American Society for Information Science, 1980). (Also available in online machine readable form.)

Robert S. Wilson et al. (eds.), Public Affairs Information Service Bulletin 1980, Vol. 66 (New York: Public Affairs Information Service, Inc., 1980).

GENERAL ONLINE COMPUTERIZED DATABASES

AMERICAN STATISTICS INDEX (ASI). A comprehensive index of the statistical publications from more than 400 central or regional issuing agencies of the U.S. government.

COMPREHENSIVE DISSERTATION ABSTRACTS. This is a definitive subject, title, and author guide to virtually every American dissertation accepted at an accredited institution since 1861, when academic doctoral degrees were first granted in the United States. All subject areas are covered.

*CONGRESSIONAL INFORMATION SERVICE (CIS/INDEX). The machine-readable form of the Congressional Information Service's Index to Publications of the United States Congress. It provides current, comprehensive access to the contents of the entire spectrum of congressional working papers published by the nearly 300 House, Senate, and joint committees and subcommittees each year.

*ENCYCLOPEDIA OF ASSOCIATIONS. This corresponds to the printed publication of the same name. It provides detailed information on several thousand trade associations, professional societies, labor unions, fraternal and patriotic organizations, and other types of groups consisting of voluntary members. In addition to the address, phone number, and size of organization, each record provides an abstract giving the scope and purpose of the organization and lists its publications and the location and date of its annual conference.

FOUNDATION DIRECTORY (The Foundation Center, New York, NY). Provides descriptions of 3,200 foundations that have assets of $1 million or more or that make grants of $100,000 or more annually. The foundations that qualify for inclusion account for nearly 90 percent of the assets of all foundations in the United States and 80 percent of all foundation giving.

FOUNDATION GRANTS INDEX (The Foundation Center, New York, NY). Contains information on grants awarded by more than 400 major American philanthropic foundations.

GPO MONTHLY CATALOG. This is the machine-readable equivalent of the printed Monthly Catalog of United States Government Publications. It contains records of reports, studies, fact sheets, maps, handbooks, conference proceedings, etc., issued by all U.S. federal government agencies, including the U.S. Congress.

MAGAZINE INDEX (Information Access Corporation, Los Altos, CA). Covers over 370 popular magazines. Coverage includes science and technology.

NATIONAL FOUNDATIONS (The Foundation Center, New York, NY). Provides records of all 21,800 U.S. foundations that award grants, regardless of the assets of the foundation or of the total amount of grants it awards annually.

*NATIONAL TECHNICAL INFORMATION SERVICE (NTIS) (NTIS, U.S. Department of Commerce, Springfield, VA). The NTIS database consists of government-sponsored research, development, and engineering plus analyses prepared by federal agencies, their contractors, or grantees. It is the means through which unclassified, publicly

available, unlimited-distribution reports are made available for sale from such agencies as NASA, DDC, DOE, HUD, and some 240 other units. State and local government agencies are now beginning to contribute their reports to the file. The NTIS database includes material from both the hard and soft sciences, including substantial material on technological applications.

SCISEARCH (Institute for Scientific Information, Philadelphia, PA). This is a multidisciplinary index to the literature of science and technology, covering about 2,600 major scientific and technical journals.

*SSIE CURRENT RESEARCH (Smithsonian Science Information Exchange, Washington, D.C.). The SSIE database contains reports of both government and privately funded scientific research projects, either currently in progress or initiated and completed during the most recent two years. SSIE data are collected from the funding organizations at the inception of a research project and provide a source for information on current research long before first or progress reports appear in the published literature. It encompasses all fields of basic and applied research in the life, physical, social, and engineering sciences.

SPECIALIZED (DISCIPLINE-ORIENTED) COMPUTERIZED DATABASES

COMPENDEX (Engineering Index, Inc., New York, NY). This is the machine-readable version of the Engineering Index (monthly/annual), which provides the engineering and information communities with abstracted information from the world's significant engineering and technological literature. The database provides worldwide coverage of approximately 3,500 journals, publications of engineering societies and organizations, papers from the proceedings of conferences, and selected government reports and books.

EXCERPTA MEDICA (Amsterdam, The Netherlands). One of the two principal sources for searching the biomedical literature. It consists of abstracts and citations of articles from over 3,500 biomedical journals published throughout the world. It covers the entire field of human medicine and related disciplines.

GEOARCHIVE (Geosystems, P.O. Box 1024, Westminster, London SW1, England). This is the world's most comprehensive and best-indexed geoscience database, indexing more than 100,000 references each year. Information indexed annually includes more than 5,000 serials, books from more than 1,000 publishers, several hundred conferences, doctoral dissertations, and technical reports. Broadly covers the fields of geophysics, geochemistry, geology, paleontology, and mathematical geology.

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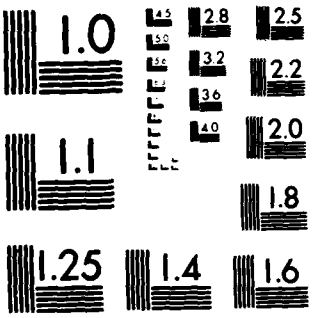


*MEDLARS (National Library of Medicine, Bethesda, MD). This database contains some 4,500,000 references to journal articles and books in the health sciences published after 1965. Based at the National Library of Medicine in Bethesda, Maryland, MEDLARS is available through a nationwide NLM network of centers at more than 1,300 universities, medical schools, hospitals, government agencies, and commercial organizations. The MEDLARS system contain 17 other online databases, including MEDLINE, which contains approximately 600,000 references to biomedical journal articles published in the current and two preceding years. The articles are from 3,000 journals published in the United States and 70 foreign countries.

METEOROLOGICAL AND GEOASTROPHYSICAL ABSTRACTS (MGA). The machine-readable file is made available through the Environmental Sciences Information Center, National Oceanic and Atmospheric Administration (NOAA), Washington, D.C. MGA provides current citations in English for the most important meteorological and geoastrophysical research published in both foreign and domestic literature. More than 7,000 citations taken from approximately 200 primary sources are added yearly. Subjects include Meteorology, Astrophysics, Physical Oceanography, Hydrosphere/Hydrology, Environmental Sciences, and Glaciology.

PAIS INTERNATIONAL. Public Affairs Information Service International (PAIS) contains references to information in all fields of social science including political science, banking, public administration, international relations, economics, law, public policy, social welfare, sociology, education, and social anthropology. Over 800 English language journals and 6,000 nonserial publications are indexed each year in the Bulletin.

PSYCHOLOGICAL ABSTRACTS (American Psychological Association, Washington, D.C.). Covers the world's literature in psychology and related disciplines in the behavioral sciences. Over 900 periodicals and 1,500 books, technical reports, and monographs are scanned each year to provide coverage of original research, reviews, discussions, theory, conference reports, panel discussions, case studies, and descriptions of apparatus.

SOCIAL SCISEARCH (The Institute for Scientific Information, Philadelphia, PA). This is a multidisciplinary database indexing every significant item from the 1,000 most important social sciences journals throughout the world and social sciences articles selected from 2,200 additional journals in the natural, physical, and biomedical sciences. Covers every area of the social and behavioral sciences.

SOCIOLOGICAL ABSTRACTS (Sociological Abstracts, Inc., San Diego, CA). Covers the world's literature in sociology and related disciplines in the social and behavioral sciences. Over 1,200 journals and other serial publications are scanned each year to provide coverage of original research reviews, discussions, monographic publications, theory, conference reports, panel discussions, and case studies.

BOOKS AND MONOGRAPHS

Jay Robert Nash, Darkest Hours (Chicago: Nelson-Hall, 1976), 812 pages. This is a narrative encyclopedia of worldwide disasters from ancient times to 1976.

Grace M. Ferrara (ed.), The Disaster File: The 1970s (New York: Facts on File, 1979), 173 pages. This is a collection of disasters of the 1970's arranged by subject (aviation, sea, etc.).

Catastrophe and Crisis (New York: Facts on File, 1979), 336 pages. This is a folio of color photographs and prints recording the worst disasters of modern times.

RESEARCH CENTERS SPECIALIZING IN EMERGENCY RESEARCH AND/OR DISSEMINATION

*Battelle Human Affairs Research Centers 4000 N.E. 41st Street Seattle, WA 98105	Battelle operates an "Emergency Management Studies Program" that engages in research on human response to natural and technological hazards. A database on citizen warning response in riverine floods and volcanic eruption is maintained. The program has recently increased research on response to nuclear power plant accidents and nuclear war threats. A library of disaster field study data is maintained. Dr. Ronald W. Perry, coordinator.
*Disaster Research Center Ohio State University Department of Sociology 128 Derby Hall 154 N. Oval Mall Columbus, Ohio 43210	Director, E. L. Quarantelli, Professor of Sociology. Has produced 410 field studies oriented to organizational behavior in disasters. Besides collecting its own data the center is a repository for documents and materials collected by other centers and researchers.
*Emergency Management Project National Governors' Association Hall of the States 444 North Capitol Washington, D.C. 20001	Hillary Whittaker, Director. The EMP of the NGA Center for Policy Research is funded by FEMA to assist states in conducting comprehensive management reviews, augment state-federal emergency systems, and study of mitigation. Publishes project reports on EM studies and in Governors' Guides.
*Hazards Information Center SRI International 1161 North Kent St. Arlington, Virginia 22209	SRI offices in Arlington house a collection of over 3,000 documents on emergency management gathered for completion of a government contract.

*Institute for Disaster Research Texas Tech. University P.O. Box 4089 Lubbock, Texas 79409	Joseph E. Minor, Director. The institute is a research organization in the College of Engineering, which oversees a wide range of emergency management studies. The institute emphasizes applied research in wind engineering. Funded by the State of Texas, NRC, NOAA, and other federal agencies. Has regular seminar series.
*Natural Hazards Research and Applications Information Center Institute of Behavioral Science #6 University of Colorado Boulder, Colorado 80309	Director, Gilbert F. White. The Natural Hazards Research Center strengthens communication between research workers and individuals, organizations, and agencies concerned with public action relating to natural hazards. The center is funded by FEMA, Corps of Engineers, NOAA, and the U.S. Geological Survey, through the National Science Foundation. Publishes a quarterly newsletter, Natural Hazards Observer, and sponsors annual workshops.
*Research Alternatives 705 New Mark Esplanade Rockville, Maryland 20850	James W. Morentz, President. Research Alternatives is a local firm that produces a monthly newsletter, Hazard Monthly, performs contract research, and distributes microprocessor-based emergency management information systems.
*The Academy for Contemporary Problems 400 North Capitol St., N.W., Suite 390 Washington, D.C. 20001	Claire B. Rubin, Senior Fellow in Public Management. Aside from research on hazard mitigation and post-disaster urban reconstruction, the academy operates the National Disaster Recovery and Mitigation Resource Referral Service. Funded by NSF and FEMA, the service is part of a project to improve the dissemination of research results on natural disaster recovery and mitigation to state and local officials.

OTHER ORGANIZATIONS INVOLVED WITH EMERGENCY MANAGEMENT

CARE 660 First Avenue New York, New York 10016	International aid and development agency providing food, self-help development, health and emergency aid, and services overseas. Publishes a quarterly newsletter.
Center for Disaster Management School of Business State University of New York Albany, New York 12222	Sal Belardo, Project Manager. The center is funded by FEMA to develop a model emergency management system (hierarchically designed). Compiling state and local data files for creation of this prototype, on nuclear system preparedness.

Church World Service
475 Riverside Drive
New York, New York
10027

Engages in works of Christian mercy, relief, technical assistance, reconstruction, and ministering to the victims of war and other emergencies such as famines and floods. Works in over 70 countries. Publishes the Hunger Fact Sheet and quarterly reports.

Committee on Natural Disasters
United States Civil Defense Council
P.O. Box 370
Portsmouth, VA 23705

J. Herbert Simpson, Executive Secretary U.S.C.D.C. Membership is from city/county/township level. Three thousand members, meets two times annually. Monthly bulletin U.S. Civil Defense Council Bulletin, free to members. Membership through dues, industrial, and other members. Contract research in emergency management.

Council for International Urban Liaison
818 18th Street N.W.
Washington, D.C. 20006

The council publishes a monthly newsletter that reports on information sources and natural and manmade disaster research institutions: The Urban Edge.

Disaster Services
American Red Cross
Red Cross Headquarters
18th and E St. N.W.
Washington, D.C. 20006

Robert D. Vessey, Director. Disaster services is the legal mandate of the Red Cross program. Red Cross interfaces with other federal agencies, state, and local government. Funded through the United Way and contributions--is independent and voluntary. Publishes guidelines on disaster relief for the 3,000 chapters.

Emergency Planning Canada
Ottawa, Canada
K1A 0W6

Honorable Yvon Pinard, President of Privy Council, Minister responsible for emergency planning. W. B. Snarr, Assistant Sec. to the Cabinet (for emergency planning). Issues quarterly the Emergency Planning Digest. National emergency planning establishment, part of the federal government (FEMA counterpart). Coordinates federal response to emergency situations. Also responsible for civil defense. Other publications are on specific EM topics.

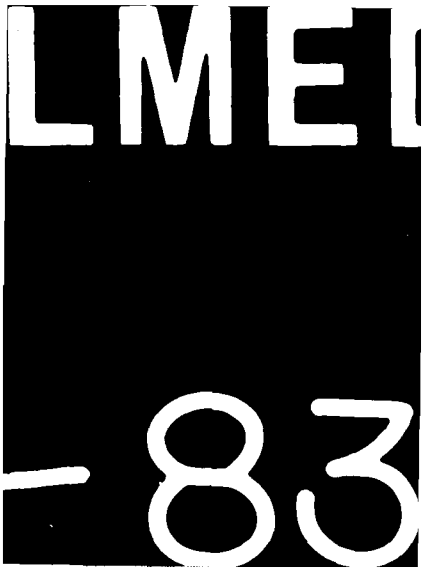
Emergency Planning Committee
International Association of Chiefs of Police
11 Firstfield Road
Gaithersburg, Maryland
20878

Chairman of the Committee, Charles L. Linstrom (Chief of Police, Holland, Mich.). The committee is the association's liaison with civil defense and disaster agencies of the United States and other nations in the IACP. Prepares guidelines and recommendations for police, civil defense, and disaster agencies in emergency situations.

International Civil Defense Organization
10-12 Chemin de Surville
CH 1213 Petit-Lancey
Geneva, Switzerland

The organization publishes International Civil Defense, a monthly bulletin on topical aspects of rescue and relief operations. Lists new publications on all aspects of disaster relief.

Joint Assistance Centre Adhyatma Sadhna Kendra Mehrauli, New Delhi-110030 India	The center publishes a journal devoted to disaster prevention and preparedness: Disaster Management.
League of Red Cross Societies 17, Chemin Des Crets Petit-Saconnex P.O. Box 276 CH-1211 Geneva 19 Switzerland	Members include National Red Cross societies, Red Crescent, and Red Lion and Sun Societies. Conducts and coordinates international disaster relief and medicosocio activities. Publishes Panorama and newsletters.
National Emergency Management Association 5636 East McDowell Phoenix, Arizona 85008	Charles A. Ott, Jr., President. NEMA represents a group of local/state officials, corporate business, and community service workers. Each state and territory is represented in the effort. Membership is through dues, meets twice annually.
Pan American Health Organization c/o Pan American Union 525 Twenty-Third St., N.W. Washington, D.C. 20037	The Pan American Health Organization is the regional representative (Western Hemisphere) for the World Health Organization, and is a center for information on disaster assistance. Publishes Disaster Preparedness in the Americas, bibliographies of publications, and monographs that focus on disasters. It also works with other groups involved with disaster relief.
Scientific Event Alert Bulletin Smithsonian Institution Sold by: National Technical Information Service U.S. Department of Commerce Springfield, Virginia 22161	Monthly bulletin on geophysical, meteoric, biologic, and other events worldwide. Covers natural disasters.
United Nations Disaster Relief Organization Palais des Nations 1211 Geneva 10 Switzerland	Publishes the bimonthly UNDRO News reporting on natural disasters around the world. Subscription is free.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